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WHITE OAK LABORATORY

PREDICTION OF IMPACT PRESSURES, FORCES, AND MOMENTS DURING VERTICAL AND OBLIQUE WATER ENTRY

15 JANUARY 1977

NAVAL SURFACE WEAPONS CENTER
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An engineering tool is described for calculating pressures and loads at high-speed water entry which is simple to use, inexpensive to exercise and applicable to a wide variety of geometries. A simplified potential model is used which replaces the water's free surface with an effective planar surface that is positioned using an empirical parameter available in the literature for a wide variety of shapes. To confirm predictions, calculations are compared to experiment for the oblique water entry of spheres,

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cones, disks, and cusps. Surface pressures agree well with measurement reflecting both the model geometry and location on the model. The calculated drag and lift exhibit close agreement with experimental values, particularly prior to the peak loads. At later times the shape of the hydraulic cavity must be taken into account and an approximate procedure for doing this is described. A computer code listing and sample computer runs are provided as well as instructions for using the code.

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PREDICTION OF IMPACT PRESSURES, FORCES, AND MOMENTS DURING VERTICAL AND OBLIQUE WATER ENTRY

This report describes a method for predicting pressures, forces, and moments on arbitrary bodies during vertical and oblique water entry. Also included is a listing of the computerized form of the technique, sample computer runs, and user instructions.

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C. A. Fisher

C. A. FISHER
By direction

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LIST OF SYMBOLS

C_p	pressure coefficient $(p - p_\infty)/(1/2\ \rho\ V_I^2)$
C_{D_∞}	drag coefficient assuming a constant model velocity
C_D	$(\text{drag force})/(1/2\ \rho\ V_I^2)/(\pi D^2/4)$
C_X	$(\text{force along x axis})/(1/2\ \rho\ V_I^2\ \pi\ D^2/4)$
C_N	$(\text{force along y axis})/(1/2\ \rho\ V_I^2)/(\pi\ D^2/4)$
C_{MX}, C_{MY}, C_{MZ}	(moment about the x,y, and z axis respectively)/ $(1/2\ \rho\ V_I^2)/(\pi D^3/4)$
C_w	wetting factor, h/h'
D	model diameter
$\bar{e}_n$	unit vector normal to the body surface
$\bar{e}_v$	unit vector parallel to the entry velocity vector
$\bar{k}$	unit vector in the z direction
h	model depth below effective planar surface (see Fig. 1)
h'	model depth below original surface (see Fig. 1)
Δh	increment in effective depth between successive steps
N	number of elements in the model
p	pressure
r	$\sqrt{x' + y'}$
t	time
t^*_m	$V_I t/D$ where t is measured from initial model impact
t^*_c	$V_I t/D$ where t is the length of time the element centroid has been submerged
t^*_e	$V_I t/D$ where t is measured from initial impact of the element
V	fluid velocity $= -\nabla\phi$

LIST OF SYMBOLS (Continued)

V_I	initial entry velocity of center of gravity
V_E	velocity of points on the model surface
V_s	surface velocity
V_p	velocity of the deepest point on the model
V_ξ, V_η, V_γ	velocity component in the element coordinate system (ξ,η,γ)
x, y, z	water surface coordinate system which is located on the surface at the point of initial model contact with the water (see Fig. 1)
x', y', z'	model fixed coordinate system (see Fig. 1)
x", y", z"	see Fig. 6
x_{cp}	(center of pressure measured from the model nose)/d
z_c	depth of element centroid
α	see Fig. 25
β	$\tan^{-1}\{-y'/r\}$
θ	entry angle (measured from the horizontal)
θ_c	cone half angle
θ_ℓ	$\tan^{-1}$ (dr/dz') where z' is axial distance along the entry body and r is the local body radius
ξ,η,γ	element coordinate system. The γ axis is perpendicular to the element surface while η and ξ are in the plane of the element
ρ	density
ϕ	velocity potential
Superscript	
$\hat{}$	nondimensionalized - see Eqs. (6)

INTRODUCTION

A common problem in the design of bodies which enter the water at high speeds is the determination of the surface pressures, forces and moments during water impact. This paper describes an engineering method for calculating these quantities. A simplified potential model is used which replaces the water's free surface with an effective planar surface that is positioned using an empirical parameter available in the literature for a wide variety of shapes. To confirm predictions, calculations are compared to experiment for the oblique entry of spheres, disks, and ogives and for the vertical entry of spheres, cones, ogives, and cusps. Surface pressures agree well with measurement reflecting both the model geometry and location on the model. The calculated drag and lift exhibit close agreement with experimental values, particularly prior to the peak loads. At later times the shape of the hydraulic cavity must be taken into account and an approximate procedure for doing this is described. A program listing and sample runs are provided as well as instructions for using the code.

Attempts to analyze the water-entry problem originate circa 1929 with the work of von Karman[1]. Comprehensive surveys of this field are provided by May[2], Thigpen[3], Szebehely[4], and Moran[5]. The main thrust of early work follows the formulation developed by von Karman and Wagner[6]. In this approach a potential

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[1] von Karman, T., "The Impact on Seaplane Floats During Landing," NACA TN 321, Oct 1929

[2] May, Albert, "Forces at Water Impact," Alden Research Laboratories, ARL 119-72/SP, Dec 1972

[3] Thigpen, A., "Water-Entry Technology - A Review," Sandia Corporation Technical Report SC-Dr 71 0196 (Jun 1971)

[4] Szebehely, V. G., "Hydrodynamic Impact," Appl. Mech. Rev., 12, 297-300, 1959

[5] Moran, J. P., "On the Hydrodynamic Theory of Water Exit and Entry," Therm Advanced Research Technical Report TAR-TR 6501 (Mar 1965)

[6] Wagner, H., "Über Stoss-und Gleitvorgänge an der Oberfläche von Flüssigkeiten," ZAMM 12, 4, 193-215, 1932

flow model is used and forces are calculated by the added mass concept. The submerged portion of the body is often fitted or replaced by another with the same surface cross-sectional area for which a closed form solution is available. A linearized version of the free-surface boundary conditions is applied to determine the surface shape. Most of the theories are restricted to vertical entry of simple geometries. In recent years, computational efforts have been made to obtain a solution using the non-linear boundary conditions. An early example of such work is that of Chu and Falconer[7]. A relaxation method was used to solve the potential problem for arbitrary bodies. This project was abandoned due to problems with excessive computational time and surface contact discontinuities. The same formulation for the vertical entry of cones has been treated by Weber[8] using a distribution of source dipoles. More recently, Shere and Vander Vorst[9] and Vander Vorst and Rogers[10] have used the marker and cell method to develop a detailed viscous model of vertical cone entry.

The objective of the current study has been to develop an engineering tool for calculating pressures and loads which is simple to use, inexpensive to exercise, and applicable to a wide variety of geometries. Accordingly, the philosophy of the current program has been to include only those portions of the problem which can be shown empirically to be necessary. The current work combines a simple flow field model with the potential flow computational techniques of Hess and Smith[11] to form an extremely versatile approach which can be applied to a wide variety of geometries over a broad range of entry conditions. The success of this calculative method indicates that a detailed description of the free surface is not necessary for the purposes of calculating entry pressures and loads.

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[7] Chu, W. -H., and Falconer, D. R., "Further Development of a More Accurate Method for Calculating Body-Water Impact Pressures," Southwest Res. Inst. Tech. Report No. 5, 1963

[8] Weber, C. F., "The Vertical Water Entry of a Cone," NOLTR 69-26, Jan 1969

[9] Shere, K. D. and Vander Vorst, M. M., "Vertical Water Entry of Finite Cones - A Numerical Calculation," Naval Surface Weapons Center, White Oak Laboratory, NOLTR 73-22, 1973

[10] Vander Vorst, M. J., and Rogers, J. C. W., "Calculation of Vertical Water Entry by the Partial Cell Marker and Cell Method," Proceedings of the 1976 Heat Transfer and Fluid Mechanics Institute, McKillop, Vaugh, and Dwyer, Standford U. Press 1976

[11] Hess, J. L. and Smith, H. M. O., "Calculation of Potential Flow About Arbitrary Bodies," Progress in Aeronautical Sciences, Edited by D. Kuchemann, Vol. 8, pp 1-138, 1967, Pergamon Press, New York, New York

PROBLEM FORMULATION

The flow field about the entering body is assumed to be described by a potential model. The free surface is simulated with an effective planar surface whose location is defined using the measured wetting factor C_w. This parameter is equal to the ratio of h/h' where h is the effective depth of the model and h' is its actual depth or penetration below the original free surface (see Fig. 1). The governing equations and boundary conditions are:

Governing equation: $$\nabla^2\phi = 0 \tag{1}$$

Boundary conditions:

(a) On body surface: $$-\nabla\phi\cdot\bar{e}_n = \bar{V}_E\cdot\bar{e}_n \tag{2}$$

(b) On the effective planar surface:

$$\begin{cases} V_s = -(C_w-1)\bar{V}_p \cdot \bar{k} & (3a) \\ \phi = 0 & (3b) \end{cases}$$

Pressures are calculated from successive solutions at differing depths using the unsteady Bernoulli equation:

$$\frac{p - p_\infty}{\rho} = \frac{\partial\phi}{\partial t} - \frac{1}{2}\ (\nabla\phi)^2 \tag{4}$$

This equation must be case in body fixed coordinates since ϕ is calculated at the same point on the body in successive steps. Thus, equation (4) becomes:

$$\frac{p - p_\infty}{\rho} = \frac{\partial\phi}{\partial t} - \bar{V}_E\cdot\nabla\phi - \frac{(\nabla\phi)^2}{2} \tag{5}$$

The above problem can be put in nondimensional form by applying the following transformations:

$$\begin{gathered} \hat{\phi} = \phi/V_I D \\ \hat{x},\ \hat{y},\ \hat{z} = x/D,\ y/D,\ z/D \\ \hat{h} = (\hat{\bar{V}}_p\cdot\bar{k})C_w t V_I/D \\ \hat{V}_s = V_s/V_I \quad \hat{\bar{V}}_p = \bar{V}_p/V_I \quad \hat{\bar{V}}_E = \bar{V}_E/V_I \end{gathered} \tag{6}$$

Now equations (1) through (3) become:

$$\nabla^2 \hat{\phi} = 0 \tag{7}$$

$$-(\nabla \hat{\phi}) \cdot \bar{e}_n = \bar{e}_n \cdot \hat{\bar{V}}_E \tag{8}$$

$$\left.\begin{array}{l} \hat{V}_s = -(C_w - 1)\hat{\bar{V}}_p \cdot \bar{k} \\ \hat{\phi} = 0 \end{array}\right\} \text{ on effective planar surface} \tag{9}$$

The nondimensional pressure is:

$$C_p = 2 \frac{\partial}{\partial t} \left[(\dot{\hat{\bar{V}}}_p \cdot \bar{k}) t C_w\right] \frac{\partial \hat{\phi}}{\partial h} - 2\hat{\bar{V}}_E \cdot \nabla \hat{\phi} - (\nabla \hat{\phi})^2 \tag{10a}$$

For constant entry conditions (i.e., $\bar{V}_p$ and C_w are fixed) the above becomes:

$$C_p = 2C_w \sin\theta \frac{\partial \hat{\phi}}{\partial h} - 2\, \bar{e}_v \cdot \nabla \hat{\phi} - (\nabla \hat{\phi})^2 \tag{10b}$$

These two equations indicate that the calculated pressure and force coefficients are independent of the model and entry velocity scale (i.e., D and V_I respectively). The value of these two parameters must be simulated through an appropriate choice of C_w. Also it is evident that for constant entry conditions, depth, not time is the most natural independent variable.

The boundary conditions used in the current study are similar to the linearized version applicable to slender bodies. The linearized conditions are that:

$$\phi = 0 \qquad \text{on} \qquad z = 0 \tag{11}$$

$$\bar{V}_s = - \frac{\partial \phi}{\partial z} (x,y,0)\ \bar{k} \tag{12}$$

These conditions follow from the nonlinearized form by dropping the quadratic terms which are second order as long as ϕ and its derivatives are small near the surface. The present model applies an empirical correction to the surface velocity described by equation (12).

POTENTIAL FLOW SOLUTION

At each depth the problem requiring solution is described by equations (7) through (9) and is directly amendable to the potential flow techniques developed by Hess and Smith which use a distribution of sources and sinks. The surface of the body under consideration is divided into quadrilaterals and a constant source strength is assumed to exist throughout each element. The source strengths are determined by satisfying equation (8) at the centroid of each element which results in a system of N simultaneous equations of the form:

$$\sum_{j=1}^{N} A_{ij}\ \sigma j = \bar{V}_E \cdot \bar{e}_{n_i} \tag{13}$$

Here σj is the source strength of element j, $\bar{e}_{n_i}$ is the unit vector normal to element i, and A_{ij} is the normal velocity induced on element i by unit source strength on element j. Equation (13) is solved directly using the method of reference 12. When the number of elements exceeds 120, solution is accomplished using a series of blocks.

Once the source strengths are determined, the velocity and potential at the centroid of each element can be calculated:

$$V_{\xi_i} = \sum_{j=1}^{N} B_{ij}\,\sigma j$$

$$V_{\eta_i} = \sum_{j=1}^{N} C_{ij}\,\sigma j \qquad (14)$$

$$\phi = \sum_{j=1}^{N} D_{ij}\,\sigma j$$

$$V_{\gamma i} = \bar{e}_v \cdot \bar{e}_{n_i}$$

Here B_{ij}, C_{ij}, and D_{ij} represent the quantities V_ξ, V_η and ϕ induced on element i by element j assuming element j has a source strength of one. The term of matrices [A], [B], [C], and [D] are evaluated using the closed-form expressions given in reference 11 which are reproduced in Appendix A. Equations (13) and (14) are cast in the inertial frame of reference where $V_\infty = 0$.

In applying the above method to the water-entry problem, only the submerged portion of the body (i.e., below the effective planar surface) is considered. The extra condition, $\phi = 0$, is satisfied on the effective planar surface by locating image elements above this surface as shown in Figure 2. The strength of the image element is equal in magnitude but opposite in sign to the original one.

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[12] Forsythe, G., and Moler, C., Computer Solution of Linear Algebraic Systems, Prentice-Hall, Englewood Cliffs, NJ, 1967

If the entry body possess symmetry about the y'-z' plane, only half of the model is gridded since symmetric element pairs have the same source strength. For such a body, four types of elements have the same source strength magnitudes and their influence coefficients are grouped together. The terms A_{ij}, B_{ij}, C_{ij} and D_{ij} reflect the influence on element i of element j, its image, the corresponding symmetric element and its image. If the entry body does not possess planar symmetry the entire face must be gridded. Here each influence coefficient reflects only the effect of an element and its image.

COMPUTATIONAL PROCEDURE

A series of points or nodes are defined on the surface of the body of interest in x', y', z' coordinates. These are arranged into groups of four to form planar quadrilateral elements as shown in Figure 3. The several different options available for defining nodes and elements on arbitrary bodies are discussed in Appendix C.

Solution of the Potential Problem

The entire body may have an aribtrary entry velocity and rotation in the y-z plane is allowed. The computation proceeds by inserting the model into the water in a series of steps each at a depth greater than the previous one. The entry velocity and the increment in model depth can be varied from step to step. At every step the group of elements comprising the submerged portion of the model are redefined and arranged into a form amenable to the calculative procedure outlined in the previous section. The nodes defining a particular element are checked to determine whether they are above or below the water line. Elements with all four nodes above the water line are discarded while those with all four below it are included without change. Element which are intersected by the water surface may have either one, two or three submerged nodes as shown in Figure 4. In all cases two new nodes are generated. Given two nodes, one below the water surface (x_1, y_1, z_1) and one above it (x_2, y_2, z_2) the new node located at the water surface on a line intersecting these two points is:

$$z_{new} = 0$$

$$y_{new} = y_1 + (y_2 - y_1)\frac{z_1}{(z_1 - z_2)} \tag{15}$$

$$x_{new} = x_1 + (x_2 - x_1)\frac{z_1}{(z_1 - z_2)}$$

When an element has only one node submerged, it is necessary to define a third new node in order to obtain a quadrilateral element. This last new node is placed midway along the surface edge of the element. If only one node is above the water surface the generation of two new nodes results in a pentalateral element. Here again, a third new node is added and the element is broken into two parts each of which is now quadrilateral.

It is necessary to define a set of element coordinates associated with each quadrilateral element used in the computations. This η, ξ, γ coordinate system is shown in Figure 5 and the corresponding unit vectors are as follows:

$$\bar{e}_\xi = \frac{(x_3-x_1)\bar{i} + (y_3-y_1)\bar{j} + (z_3-z_1)\bar{k}}{\sqrt{(x_3-x_1)^2 + (y_3-y_1)^2 + (z_3-z_1)^2}}$$

$$\bar{e}_\gamma = \frac{\bar{e}_\xi X[(x_2-x_4)\bar{i} + (y_2-y_4)\bar{j} + (z_2-z_4)\bar{k}]}{|\bar{e}_\xi X[(x_2-x_4)\bar{i} + (y_2-y_4)\bar{j} + (z_2-z_4)\bar{k}]|} \tag{16}$$

$$\bar{e}_\eta = \bar{e}_r X \bar{e}_\xi$$

Here the subscripts refer to the corner numbers shown in Figure 5.

At every step, equations (1) to (3) are solved using the potential flow method discussed in the last section. The value of the velocity and potential at each element centroid is stored for future use in determining C_p. In the case of elements which have been split into two (Fig. 4c), a single area weighted average value is retained.

Calculation of Surface Pressures

At each depth the pressure coefficient, C_p, is evaluated at each element centroid using equation (5) which is in a body fixed frame of reference:

$$C_p = \frac{p-p_\infty}{\frac{1}{2}\rho V_I^2} = \frac{2}{V_I^2}\frac{\partial\phi}{\partial t} + \frac{2\bar{V}_E\cdot\bar{V}}{V_I^2} - \left(\frac{V}{V_I}\right)^2 \tag{17}$$

The fluid velocity, $\bar{V}$, which appears in this equation is directly determined at each depth, but $\frac{\partial\phi}{\partial t}$ must be calculated using the value of ϕ at the same body locations in adjacent steps. The general expression used to calculate this quantity at the n^{th} step is:

$$\left.\frac{\partial\phi}{\partial t}\right|_n = \dot{\phi}_{n-1} + (\dot{\phi}_{n+1} - \dot{\phi}_{n-1}) \frac{\Delta t_{n-1}}{[\Delta t_{n+1} + \Delta t_{n-1}]}$$

$$\dot{\phi}_{n-1} = \frac{\phi_{c_n} - \phi_{c_n} - 1}{\Delta t_{n-1}} \tag{18}$$

$$\dot{\phi}_{n+1} = \frac{\phi_{c_{n+1}} - \phi_{c_n}}{\Delta t_{n+1}}$$

Here ϕ_{c_n} is the value of the potential at the element centroid where the pressure is being calculated at the n^{th} step. The quantity Δt_{n-1} is the time interval between steps n-1 and n. Similarly, Δt_{n+1} is the time interval between steps n and n+1. Note that if $\Delta t_{n-1} = \Delta t_{n+1}$, the above expression reduces to the central difference.

$$\frac{\partial \phi}{\partial t}\bigg|_n = \frac{\phi_{c_{n+1}} - \phi_{c_{n-1}}}{2\Delta t_{n+1}} \tag{19}$$

Special problems arise in calculating $\frac{\partial \phi}{\partial t}\Big|_n$ for elements which are modified (i.e., intersected by the water surface) in any of steps n-1, n, and n+1. This is because the body fixed coordinate of a modified element centroid differs from its unmodified value and hence ϕ is not known at the same point on the body surface for the required number of adjacent steps. To handle this situation local similarity is assumed. This assumption holds that at any point within an element ϕ is only a function of the length of time that this point has been submerged. This removes the necessity of knowing ϕ at the same point on the body surface. Hence the values of ϕ associated with the same element centroid are used in equation (18) regardless of whether the element is modified in any of the three required adjacent steps. If an element is modified, the associated time interval between it and preceeding or following steps to be used in equation (18) is no longer the time interval between successive steps. The required time interval to be used in place of Δt_{n-1} is:

$$\Delta t = \frac{h_n - h_{n-1}}{C'_w V_z} \tag{20}$$

An analogous expression applies for determining Δt_{n+1}. Here h_n is the depth of the element centroid at step n while C'_w and V_z are the wetting factor and the z velocity component of the element centroid between steps n-1 and n. Since the model may rotate in the y-z plane the velocity vector of different points on the body surface will vary with location. Hence, the wetting factor C'_w used in equation (20) is a local value and not that prescribed for the entry body. Between steps n-1 and n this parameter is calculated from:

$$C'_w = \frac{V_z + (\bar{V}_p \cdot \bar{k})(C_w - 1)}{V_z} \tag{21}$$

where C_w is the prescribed time interval and wetting factors between n-1 and n. An analogous expression is used to determine C_w between steps n and n + 1.

For modified elements located near the water surface it is also possible to use the boundary condition $\phi_{n-1} = 0$ at $h_{n-1} = 0$. This condition must be applied if the element at which the pressure is to be calculated is not present in the preceding step (i.e., no part of it was submerged). It has also been found advantageous to use this condition for elements modified in step n.

The local similarity assumption is strictly applicable for the oblique entry under constant velocity and orientation of an infinite plate. For plates of infinite length but finite and constant cross-sectional geometry this assumption holds in x = constant planes shown in Figure 6. This assumption is well founded for bodies where conical similarity is applicable if for successive steps $\Delta h << h$. On three-dimensional models this assumption is most accurate on portions of the model where the surface geometry varies slowly.

The pressure coefficient on the model at the water surface is singular. This can be seen by casting equation (4) in a frame of reference moving with the effective planar surface.

$$C_p = \frac{2}{V_I^2}\left[\frac{\partial\phi}{\partial t} + V_s \cdot V - \frac{(V)^2}{2}\right]$$

On this surface $\frac{\partial\phi}{\partial t} = 0$. Due to a source discontinuity at the intersection of the model and the water surface $V \rightarrow -\infty$ and $C_p \rightarrow -\infty$. Fortunately, the value of C_p recovers quickly with depth and assumes a positive value well before the experimentally observed pressure peak. For the element sizes used in this study the first value of pressure calculated for each element is usually positive.

Negative C_p values can also be obtained on the sides of the entering body if allowance is not made for the flow cavity. Such values are set to zero for the purposes of calculating total model loads.

USE OF THE NUMERICAL MODEL

In using the described numerical model it is necessary to specify the wetting factor, C_w, the increment in depth between successive steps (Δh) and to construct an appropriate grid. In some cases it is also advisable to apply a correction to the pressure calculated on modified elements. The parameter C_w can be determined from a body of existing experimental data which will be reviewed in conjunction with specific applications. The numerical effect on C_{D_∞} and C_p of varying C_w is illustrated in Figures 7 and 8 respectively.

With decreasing values of C_w, C_{D_∞} is reduced in magnitude and peak values occur at a later time. The peak pressure coefficient increases with increasing values of C_w, but its rate of decay is also accelerated.

Selection of Δh

The flow field properties at any particular depth are independent of solutions at other depths and hence of Δh. However, calculation of C_p, as discussed in the previous section, requires values of ϕ from adjacent steps. In as much as the present method calculates only a single pressure for each element, it is desirable that this pressure represent an average for the element. To ascertain an appropriate step size for accomplishing this, the constant velocity and orientation entry of the flat plate of finite length shown in Figure 6 is considered. Defining $\bar{h}$ to be the depth of an arbitrary point p on the surface of the plate:

$$\left.\frac{\partial\phi}{\partial t}\right|_p = \left.\frac{\partial\bar{h}}{\partial t}\frac{\partial\phi}{\partial\bar{h}}\right|_p = C_w \sin\theta V_I \left.\frac{\partial\phi}{\partial\bar{h}}\right|_p$$

Transforming the above into the x", y", z" coordinate system of Figure 6 which is fixed on the effective planar surface:

$$\left.\frac{\partial\phi}{\partial t}\right|_p = (C_w \sin\theta V_I)\left[\frac{\partial\phi}{\partial y''}\frac{1}{\cos\theta}\right]_p$$

The average value of $\frac{\partial\phi}{\partial t}$ for the rectangular elements shown in Figure 6 with a pair of edges parallel to the water surface is:

$$\overline{\frac{\partial\phi}{\partial t}} = \frac{C_w \sin\theta V_I}{A\cos\theta}\int_{x_1''}^{x_2''}\int_{y_1''}^{y_2''}\frac{\partial\phi}{\partial y''}\,dy''dx'' = \frac{C_w \sin\theta V_I[\phi^*(\bar{h}_2) - \phi^*(\bar{h}_1)]}{(\bar{h}_2 - \bar{h}_1)} \tag{23}$$

or

$$\overline{\frac{\partial\phi}{\partial t}} = \frac{\phi^*(t_2) - \phi^*(t_1)}{(t_2 - t_1)}$$

Here $\phi^*(t_1)$ and $\phi^*(t_2)$ are the average values of ϕ along the upper and lower edges of the element respectively, A is the element area, and t_2 and t_1 are the lengths of time that the lower and upper edges of the element have been submerged.

Equation (23) is of the same form as the central difference expression used in evaluating $\frac{\partial\phi}{\partial t}$ (equ. (19)). If the pressure on the rectangular element of Figure 6 is being evaluated at step n, equations (19) and (23) become identical if the step size is chosen such that at step n-1 and n+1 the element centroid lies at the top and bottom edges of the element in step n respectively. Hence the step size should be chosen so that each element is completely submerged in two steps or

$$\Delta h = (y_2{}^1 - y_1{}^1)\cos\theta/2$$

The preceeding analysis is not strictly applicable to three-dimensional bodies entering with variable velocity and orientation and composed quadrilateral elements with edges not necessarily parallel to the water surface. However, it is taken as a guide and Δh is picked to insure that the average element is submerged in two steps. Thus,

$$\Delta h \sim \ell \cos \theta'/2 \tag{24}$$

where ℓ is the element characteristic length and θ' is the typical element orientation angle with respect to the vertical. This criteria is easily applied on flat plates or cones. Spheres and other bodies with curvature in the axial direction are more difficult to deal with. The above is satisfied only approximately with elements perpendicular to the direction of motion being most heavily weighted. In practice, it is these elements which experience the largest pressures and hence are most crucial to the problem solution. On bodies with curvature in the axial direction the size of the elements is increased as their orientation approaches the direction of motion.

The effect of varying grid size and hence Δh on C_{D_∞} and C_p is illustrated in Figures 9 and 10 respectively. On flat surfaces an accurate solution is obtained with only a small number of elements. The principal effect of increasing the number of elements is to reduce the peak calculated pressure. Since these peak pressures act over small areas the drag coefficient is relatively insensitive to increases in the number of elements. More complex shapes naturally require the use of a larger number of elements.

Describing the Entry Body with Quadrilateral Elements

In setting up a grid, best results are obtained if the afterbody is neglected and only the nose of the entering body is gridded. The pressures and source strengths on afterbody elements are small. On models with well rounded shoulders exclusion of these elements decreases the required computational effort without strongly effecting the solution. On models with sharp edges such as disk cylinders, inclusion of the afterbody elements imposes the requirement that the flow make a sharp turn about the edge of the face. This requirement is physically unrealistic since the flow will separate at the face edge. Use of afterbody elements in this case increases the flow velocity on elements near the edge which in turn decreases the calculated pressures. This is illustrated in Figures 11 and 12 which give the calculated drag for the oblique entry of a disk cylinder with and without afterbody element respectively. Results obtained in Figure 12 without the use of afterbody elements are in much closer agreement with experimental results and required a smaller amount of computational effort.

Cavity Modeling Using No Load Elements

At time following peak impact loading the existence of the flow separation region or cavity about the afterbody of entry models may have a significant effect on the model surface pressures and positive steps must be taken to model it.

Accordingly, no load elements have been introduced into the computations. These elements are placed on the water-cavity interface and their purpose is to force the flow to attain the correct streamlines in this vicinity. Loads on these elements are not included in the drag and lift totals for the entry body.

No load elements are placed on a surface extending from the position on the model where separation occurs to the effective planar surface. The actual location of each element is adjusted in successive runs until the pressures on it is at a desired level ($C_p = 0$ for a vented cavity). Typical results for a disk cylinder are shown in Figure 13 assuming a vented cavity. In this case the cavity was modeled using a single ring of elements extending from the edge of the face to the effective planar surface. Although the procedure for locating the no loads elements is not automated and therefore somewhat tedious, the results do account for much of the difference between experiment and theory. Fortunately, it is generally not necessary to include the cavity at times prior to the peak load.

Correcting Pressure on Modified Elements

During the vertical entry of axisymmetric bodies it is appropriate to apply a correction to the pressures calculated on modified elements. Under these conditions the body is gridded with elements having a pair of sides parallel to the water surface. Following the step size rule of equation (24) elements are submerged in exactly two steps. On odd numbered steps the elements adjacent to the water surface are all modified while in even numbered ones they are not modified. Apparently, the pressure levels predicted in the odd steps are not consistent with those calculated in the even ones. This is illustrated by considering the vertical entry of a 22.5, 45 and 70 degree half-angle cones. The drag coefficients, non-dimensionalized by the local surface diameter, are given in Table 1 as a function of depth. Since this problem is conical in nature the drag should be the same at each depth. For the first few steps error may be expected since the entire cone is being modeled with only a few elements. However, results should converge to a common value. It is clear from Table 1 that the odd and even number steps are converging to different values. In order to determine the better of the two answers, calculated pressure distributions are compared to experiment for typical odd and even numbered steps in Figures 14 and 15. These pressure distributions are very similar except near the water surface. Figure 14 clearly shows that the pressure on the modified element is too large. A simple correction factor, F_c, can be determined which when multiplied by the pressure on the modified element brings the total drag calculated in even and odd steps into line with one another. The value of this correction factor has been plotted in Figure 16 as a function of depth for the three different cones under consideration.

When applying the present model to the vertical entry of axisymmetric bodies, either the drag calculated in odd numbered steps should be ignored or the correction factor F_c should be used. In the remainder of this report a value of .67 is used.

The above problem does not arise during oblique entry since the edges of the generated elements are not parallel with the water surface and the number of modified elements is fairly constant from step to step. This does not mean that such a correction is not necessary. However, there is no systematic method for chosing F_c on general bodies. Experience suggests that on slender bodies (nose length/D >1) a value of .67 should be used and in all other oblique entry cases F_c should be set to unity.

APPLICATION OF THE CODE TO SPECIFIC EXAMPLES

The previously described computer program has been applied to the oblique entry of disk cylinders, ogives, spheres, and to the vertical entry of ogives, cusps, cones, and spheres. In this section these calculations are compared to experimental results. In assessing the validity of the water-entry model it should be kept in mind that some uncertainty exists with regard to many of the experimentally determined quantities. Also, measured quantities may not be equivalent to calculated ones. The measured pressure represents the value at a specific point on the model while the calculated result reflects the average for an element of finite size. These two quantities become synonymous on elements well below the water surface.

Vertical Entry of Axisymmetric Bodies

In this section the vertical entry of cones, cusps, spheres, and ogives is considered. The two-dimensional nature of these problems insures that a single value of C_w accurately characterizes the rate of surface wetting about the entire perifery of the model. Also, separation of flow on cones and cusps can be categorically ruled out until after the shoulder of the model has entered the water. These cases thus provide an ideal opportunity for testing the proposed predictive method.

Vertical cone entry calculations are compared to the experimental results of Baldwin[13,14] which were taken at entry velocities of 16 to 32 ft/sec. Using a correlation developed in this work, an expression for the wetting factor can be obtained which is applicable to cones with a half angle greater than 7.5 degrees:

$$C_w = \frac{1}{[1. - .396\theta_c + .287\theta_c^{\,2} - .124\theta_c^{\,3}]} \tag{25}$$

Here θ_c is the cone half angle in radians. Measured and calculated pressure coefficients on 22.5, 45, and 70 degree half-angle cones are shown in Figures 15, 17, and 18. The experimental values represent a correlation based on

[13] Baldwin, J. L., An Experimental Investigation of Water Entry, PhD Dissertation, U. of Maryland, 1972

[14] Baldwin, J. L., "Vertical Water Entry of Cones," Naval Surface Weapons Center, White Oak Laboratory, NOLTR 71-25 (1971)

conical similarity which has been corrected to reflect a constant entry velocity. Use of normalized depth as the independent variable is appropriate since the computational model also produces conically similar results. Excellent agreement is obtained between calculations and experiment. In particular, predicted pressure coefficients reflect the reversal in functional form exhibited by the data with increasing cone angle. Experimental data near the tip of the cone is not shown since Baldwin has indicated that there were an absence of measurements in the region[15].

In Figure 19, the calculated drag of finite length cones are compared to Baldwin's results. Good agreement exists up to the point where the cone becomes completely submerged which coincides with the occurrence of peak drag. At later times the calculated values are too low. Improved agreement between experiment and theory would probably be obtained if the cavity were modeled.

The calculated drag on vertically entering cusps and ogives are compared to the experimental measurements of reference (16) in Figures 20 to 23. The dimensions of these bodies are given in their respective figures. Predicted values are in good agreement with experiment prior to the drag peak. To accurately determine the drag peak on the cusp models the grid was extended past the actual shoulder by one row of elements. The present calculative method anticipates the end of the cusp one step before it occurs making this procedure necessary (see Equ. (18)). At times following the point of peak drag, forces on the entry body are calculated both with and without a simulated cavity. In the cases depicted in Figures 20, 21, and 23, inclusion of the cavity brings the computed drag into close agreement with experiment. The formation of a cavity does not appear important for the ogive of Figure 22. This body is the slenderest of the four models with little surface discontinuity at the shoulder-afterbody junction.

A systematic method for determining C_w in the above four cases involves substituting the local body angle, θ_ℓ, into equation (25) to determine C_w as a function of time. It would seem plausible to use either the local angle on the effective planar surface or at the original surface. The validity of these two approaches can be examined for the cusp models where the peak drag can be assumed to occur as the shoulder of the model is wetted. The better of these two methods is the latter, but even it overpredicts C_w resulting in a premature wetting of the shoulder. A correction factor can be determined which

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[15] Baldwin, J. L. Private communication

[16] Baldwin, J. L., "Vertical Water Entry of Some Ogives, Cones, and Cusps", NSWC/WOL/TR 75-20, Mar 1975

produces the actual time of shoulder wetting when multiplied by the C_w factors calculated from equation (25) using θ_ℓ at the original surface. The results shown in Figures 20 and 21 reflect correction factor values of .97 and .94 respectively. Correction factor with values greater than unity might be postulated for ogives since their profiles are convex instead of concave. However, this type of adjustment was not carried out and the computations for the ogive models used the values of C_w defined by equation (25). Examination of Figures 22 and 23 indicates that such a correction would have reduced the discrepancy between theory and experiment.

Calculations for the vertical entry of a sphere are compared to Nisewanger's[17] experimental measurements. These tests were made at an entry velocity of 23.5 ft/sec. Pressures were measured at a number of points on the model surface and integrated to produce total drag. The response times of successive gages were used to give the following expression for the wetting factor:

$$C_w = 1.736 - .829\sqrt{t^*} \qquad (26)$$

Calculated pressures are compared to measured ones in Figures 24 through 26. Only the pressure measurements made while the transducers were fully wetted are shown. The predicted stagnation pressure is over estimated at early times but in good agreement otherwise. At intermediate distances from the stagnation point the predicted pressure is below the measured one. However, far from the stagnation point, as is shown in Figure 26, the calculated pressure is again close to experiment. The predicted drag is compared to experiment in Figure 27 with best agreement being obtained at early times. The measured drag does not account for model deceleration. However, these results are in good agreement with Mosteller's[18] constant velocity data.

Oblique Entry of Arbitrary Bodies

The oblique entry of arbitrary bodies constitutes a more rigorous test of the predictive method since these cases are three dimensional. Calculations are compared to experiment for cones, disk cylinders, spheres, and ogives.

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[17] Nisewanger, C. R., "Experimental Determination of Pressure Distribution on a Sphere During Water Entry", NAVWEPS Report 7808, Oct 1961

[18] Mosteller, G. G., "Axial Deceleration at Oblique Water Entry of 2-Inch-Diameter Models with Hemisphere and Disk-Cylinder Noses", NOTS NAVORD Rept. 5424, (1957)

Predicted and measured pressure distribution on a 45 degree half-angle cone entering vertically but at an agle of attack are shown in Figure 28. The experimental data are unpublished results of J. L. Baldwin of NSWC/WOL taken on the windward and leeward ray of the cone at incidences of 10 and 20 degrees. Equation (25) was used to determine C_w. On the windward ray the cone angle was incremented by the angle of attack while on the leeward side it was decreased by this amount. As can be seen from this figure, results are generally in good agreement with measurements.

Experimental data on the oblique entry of disk cylinders can be found in the work of Norman[19], Mosteller[18], and Baldwin[13], representing entry velocities of 25 to 325 ft/sec. Based on the latter two sources and data taken in the present study, a C_w value of 1.45 is selected for all entry angles. Existing information for this parameter, shown in Figure 29, contains extensive scatter and hence this choice is a rough estimate. In Figure 12, the calculated drag is compared to Baldwin's empirical correlation of experimental data. Both theory and experiment agree quite well over a wide range in entry angle. Calculated pressures are compared to Aronson's experimental data in Figure 30*.

In Figures 31 and 32 calculations are compared to Aronson's pressure measurements on a three-inch-diameter ogive cylinder entering obliquely at 100 ft/sec and an angle of 60 degrees. This body has a flat face, 1.5 inches in diameter, and rounded shoulders with radii of .75 inches. The mean measure C_w value of 1.36 is used in the computations. Experimental results indicate that pressures rise more quickly, to a higher peak and fall more rapidly on the lower portion of the model face. This is particularly evident for measurements made on the shoulder of the model. The computed results closely reflect this change in the pressure trace associated with transducer location. However, peak pressures are consistently overpredicted. Fortunately, the high peak pressures act on extremely small areas and thus have little effect on the actual load for the size elements being used. To illustrate this point, experimental and calculated loads on the computational element nearest to the center of the face are plotted in Figure 33. The experimental load is obtained by applying the data from location 1 in Figure 32. The pressure-time history of each point in the computational element is assumed described by this relation.

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[19] Norman, J. W., Burden, W. J., and Suter, R. A., "Deceleration at Water Entry-IV, The Effects of Velocity, Entry Angle and Pitch on a Projectile with a Flat Cylindrical Head", ARL/R5/G/HY/2/3, 1960

*A brief summary of this experimental work will soon be available from the National Technical Information Service in a report titled "Prediction of Surface Pressures During Water Impact" by Wardlaw and Aronson

In Figure 27 the calculated drag for the oblique entry of a sphere is plotted against experimentally smoothed curves given by May[3] which are constructed from the data of references (18), (20), (21), and (22). This information reflects entry velocities between 11 and 225 ft/sec. The wetting factor for the oblique entry of a sphere has not been extensively investigated. A value of 1.35 was selected based on White's[23] limited results. Reasonably good agreement is obtained between calculated and experimental values.

Calculated loads on a slender ogive body entering obliquely are compared in Figures 34 and 35 to the unpublished drag, normal force and pitching moment data by Baldwin. The wetting factor for this case does not appear to have been investigated experimentally. A value of 1.1 is used which corresponded to the average value obtained for the vertical entry of this body using equation (25). Best agreement between measurements and calculations occurred using the OGIVE grid option, discussed in Appendix C, which produces elements with a pair of edges parallel to the water surface. Consistent with previous discussion, the calculated loads at odd numbered steps are discarded. Analytical results are in closest agreement with experiment at the entry angle of 75 degrees as shown in Figure 35. The premature decrease in the calculated drag at $\theta = 45°$ in Figure 34 can probably be attributed to the formation of a cavity along the upper surface of the ogive. The use of no load elements to model the water-cavity interface could conceivably decrease this discrepancy. Consistent with trends visible in previous examples, the underprediction of the drag initially occurs near the point where the total load on the slender ogive model peaks.

The present calculative procedure does not include the contribution to normal force and pitching from the formation of an underpressure cavity. Hence in cases where this effect is important the calculated normal force and pitching moment will not be very accurate.

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[20] Hobbs, E. V., Breakstone, H. I., and Woodson, J. B., "Oblique Entry of Spheres into Water", NBS Rept. 2788 (1951)

[21] Hydroballistics Design Handbook, BuOrd NAVORD Rept. 3533 (1955)

[22] Norman, J. W., Burden, W. J., and Suter, R. A., "Deceleration at Water Entry-III, Velocity, Entry Angle, and Pitch Effects on a Projectile with a Hemisphere Head", ARL/R4/G/HY/2/3 (1959)

[23] White, F. G., "Photographic Studies of Splash in Vertical and Oblique Water Entry of Spheres", NAVORD Report 1228, 1950

SUMMARY AND CONCLUSIONS

This technical report outlines a systematic method for calculating surface pressures, forces and moments on arbitrary bodies during the early phases of water entry. A potential flow model is assumed and the free surface is approximated by an effective planar surface empirically located at the splash height. The computational techniques of Smith and Hess are used to solve the the potential problem. This requires that the surface of the body be described by planar quadrilateral elements. Using Bernoulli's equation the average pressure is calculated on each element and then integrated to produce total forces and moments on the entry body. Through the use of no load elements it is possible to model the cavity which form about the entry body, but this is generally not necessary.

The described method of calculation has been applied to a number of different cases in which experimental data is available. For vertical entry this includes cones with and without angle of attack, ogives, cusps, and spheres. The oblique entry case has been studied for disk cylinders, spheres, blunt and slender ogives covering entry angles between 30 and 90 degrees. The predicted pressure traces accurately duplicate experimental results, reflecting not only overall body geometry but also location on the body surface. The calculated loads are in good agreement with experimental values, particularly prior to the point of peak loading. At later times no load elements must be used to model the water-cavity interface.

Although the current predictive method is a viable engineering tool, some shortcomings are evident. Most notably, pressures on elements adjacent to the water surface are often overpredicted. This is not surprising considering the singularity which exists at the water surface in the current formulation. An empirical correlation scheme based on an experimental data correlation (e.g., reference (24)) might offer substantial improvement. Finally, it is clear from the studied examples that positive steps must be taken to model the cavity after the point of peak load. Provisions should be made for automating this procedure.

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[24] Baldwin, J. L., and Steves, H. K., "Vertical Water Entry on Spheres", NSWC/WOL/TR 75-49, May 1975

TABLE 1 CALCULATE CONE DRAG AS A FUNCTION OF STEP NO. AT ODD NUMBER STEPS ELEMENT ADJACENT TO THE WATER SURFACE IS MODIFIED WHILE ON EVEN NUMBER STEPS IT IS NOT.

STEP NO. \ θ_c	22.5°	45°	70°
1	0.565	2.178	9.218
2	0.455	1.815	7.964
3	0.430	1.744	7.902
4	0.333	1.455	6.528
5	0.396	1.611	7.376
6	0.333	1.391	6.356
7	0.373	1.543	7.166
8	0.323	1.369	6.300
9	0.362	1.511	7.042
10	0.322	1.361	6.276
11	0.354	1.483	6.925
12	0.321	1.354	6.267
13	0.349	1.463	6.850
14	0.320	1.349	6.258
15	0.346	1.432	6.790
16	0.321	1.344	—

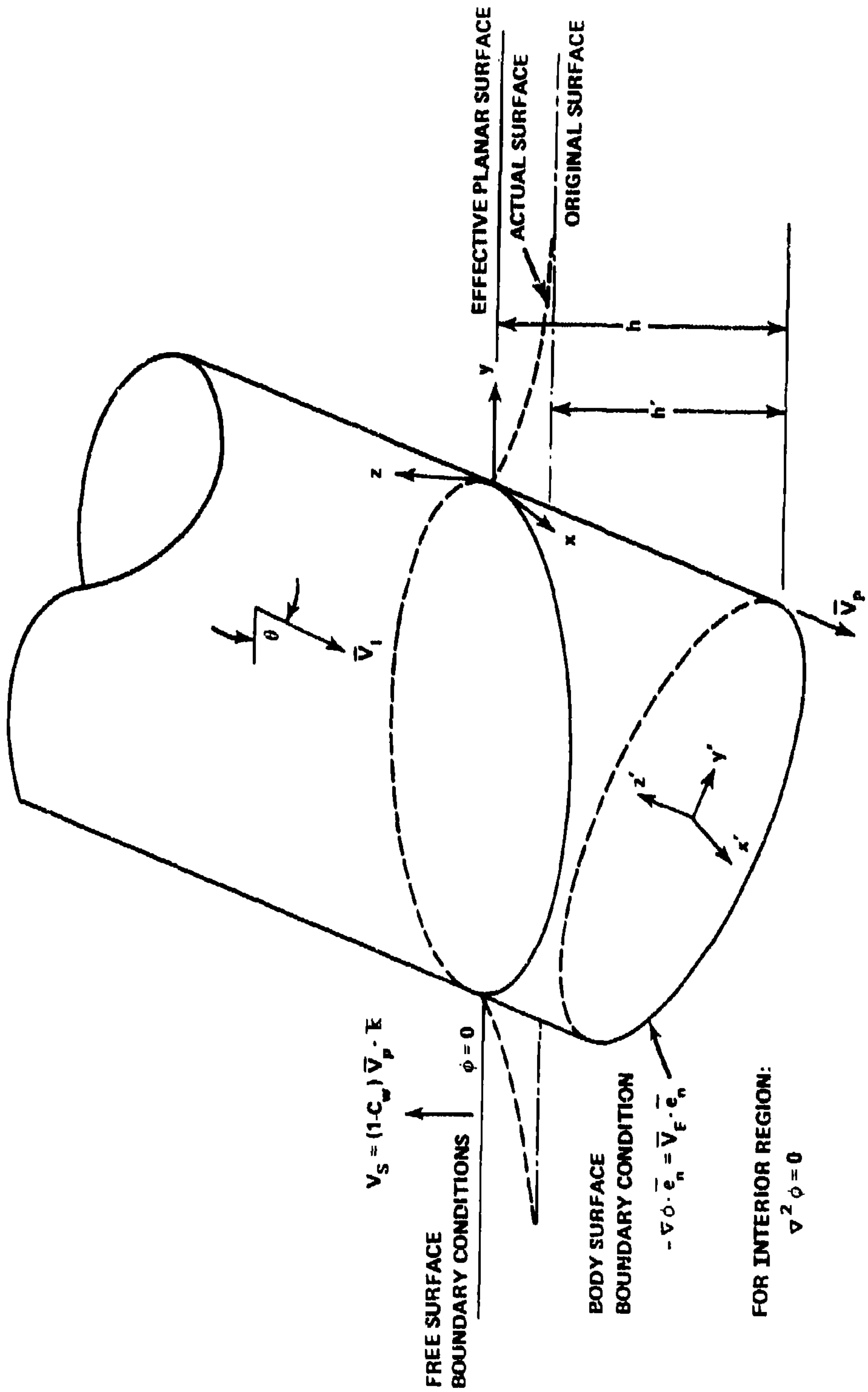

FIG. 1 PROBLEM FORMULATION

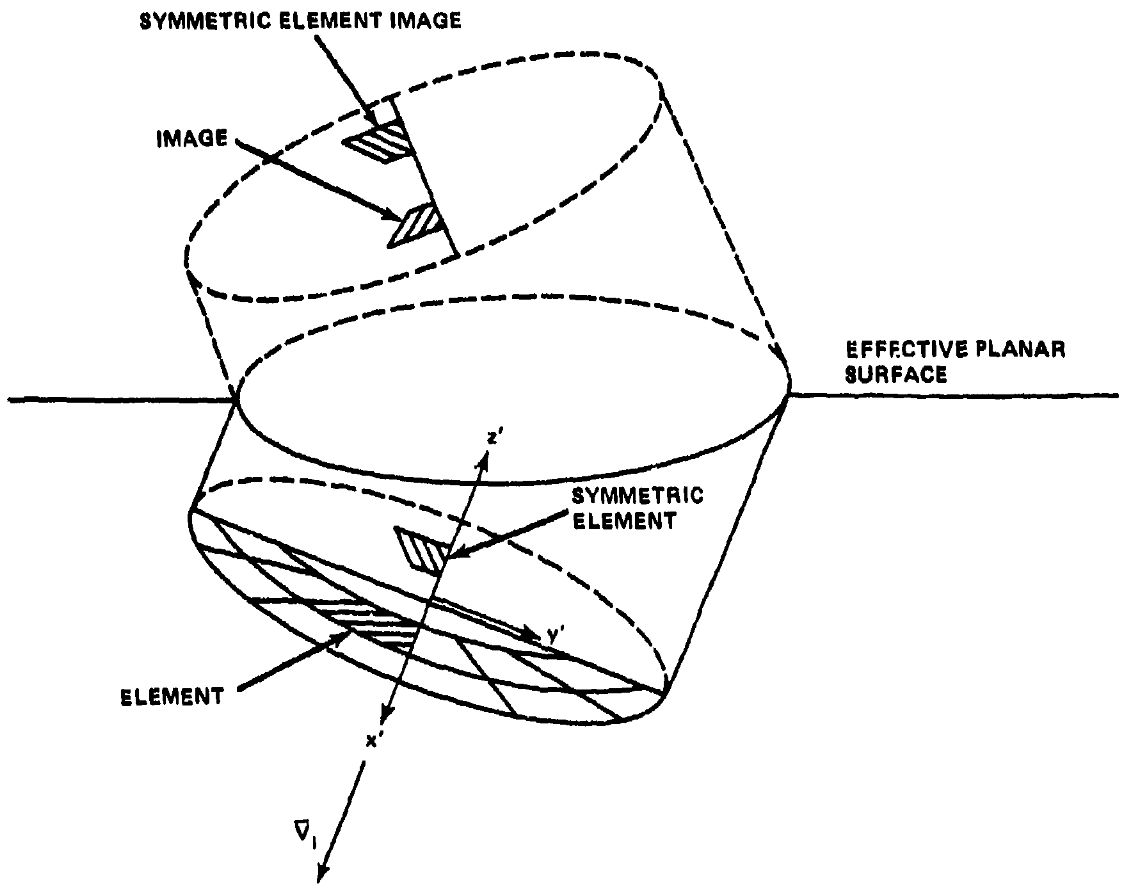

FIG. 2 ELEMENTS WITH SIMILAR SOURCE STRENGTHS. ONLY HALF OF A BODY WITH y' - z' PLANE IS GRIDDED. EACH ELEMENT HAS A CORRESPONDING SYMMETRIC, IMAGE AND IMAGE SYMMETRIC ELEMENT OF THE SAME SOURCE STRENGTH MAGNITUDE.

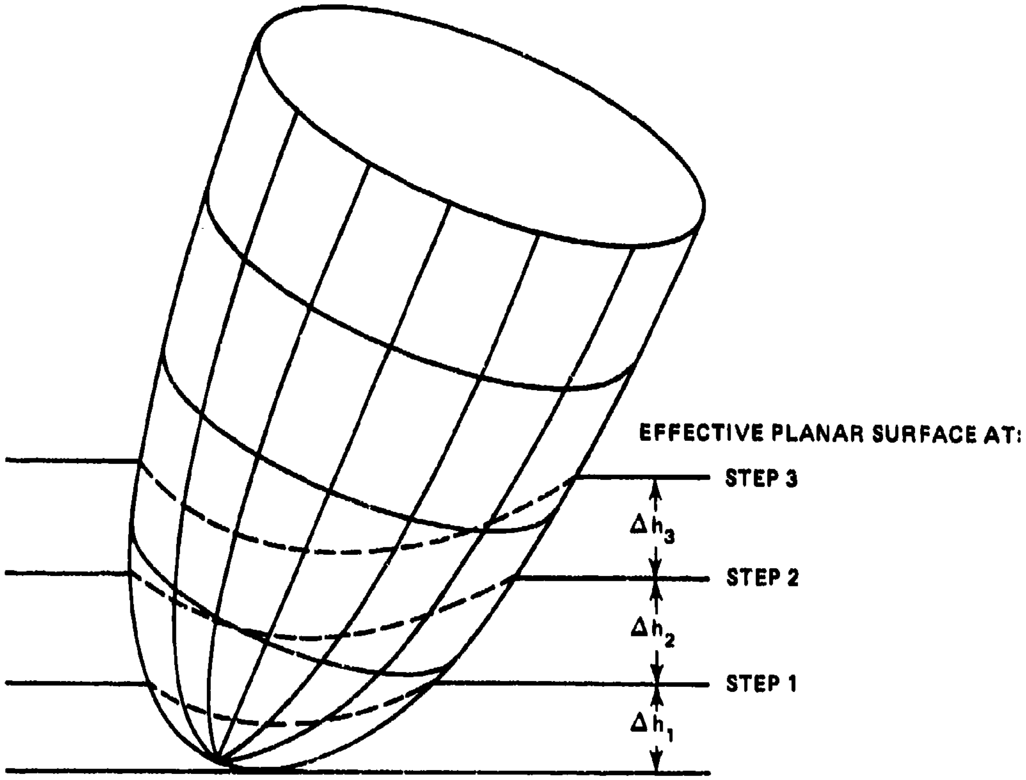

FIG. 3 COMPUTATIONAL GRID. THE MODEL SURFACE IS DIVIDED INTO PLANAR QUADRILATERAL ELEMENTS. ALSO SHOWN IS THE INTERSECTION OF THE WATER SURFACE AND THE MODEL DURING THE FIRST THREE STEPS.

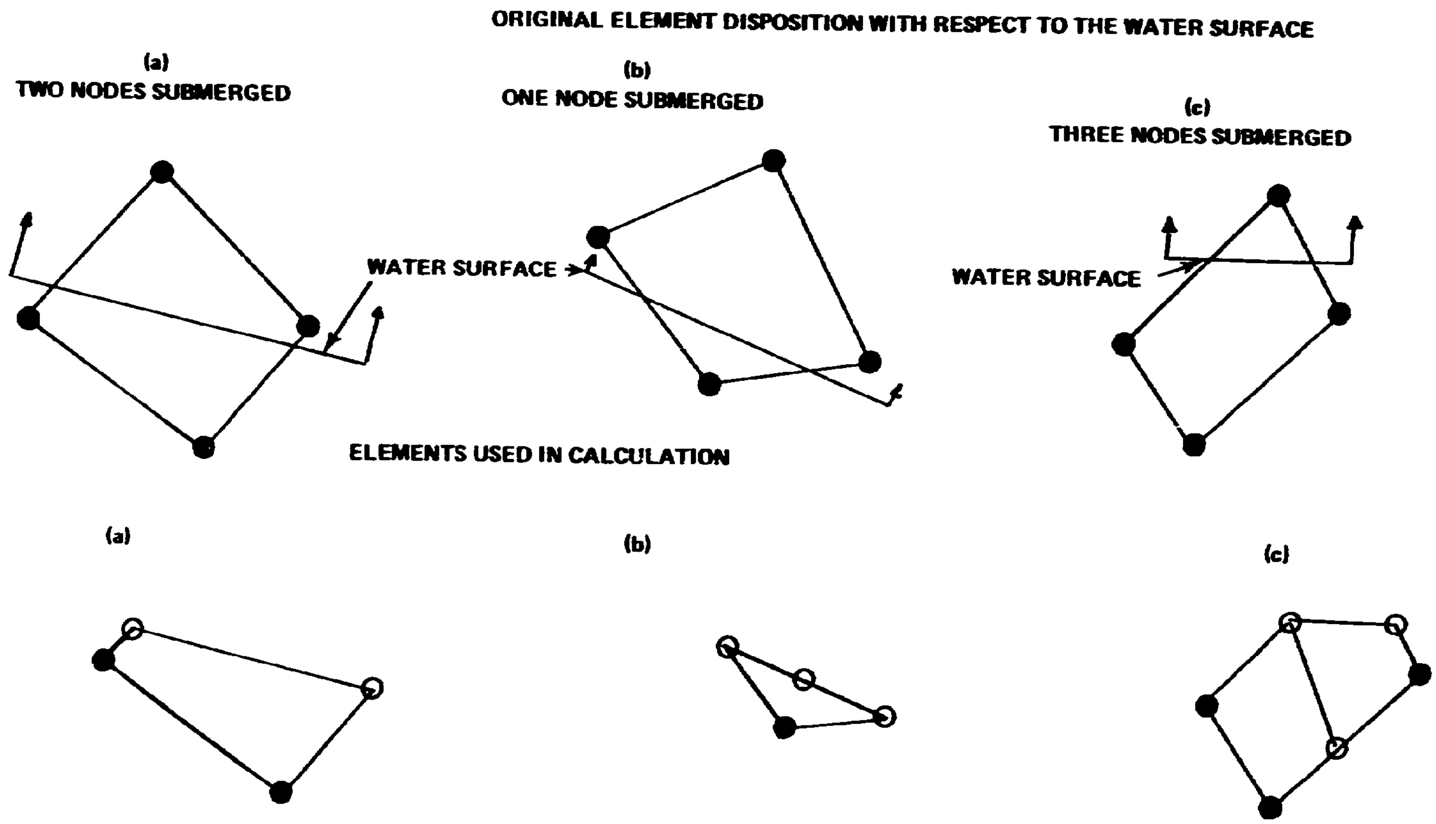

FIG. 4 ELEMENTS WHICH ARE INTERSECTED BY THE WATER SURFACE ARE REDEFINED. THE THREE POSSIBLE CASES WHICH CAN ARISE ARE DEPICTED. ● REPRESENT ORIGINAL NODES. ○ ARE THE GENERATED NODES LYING ON THE WATER SURFACE.

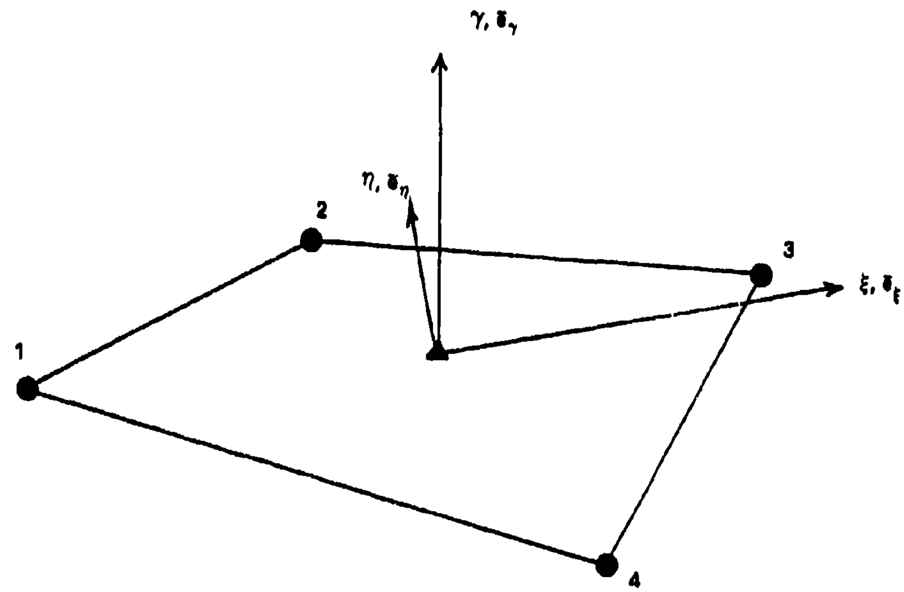

FIG. 5 THE NODES DEFINING EACH ELEMENT ARE ARRANGED IN CLOCKWISE ORDER. A ξ, η, γ COORDINATE SYSTEM IS DEFINED FOR EACH ELEMENT AND LOCATED AT THE ELEMENT CENTROIDE.

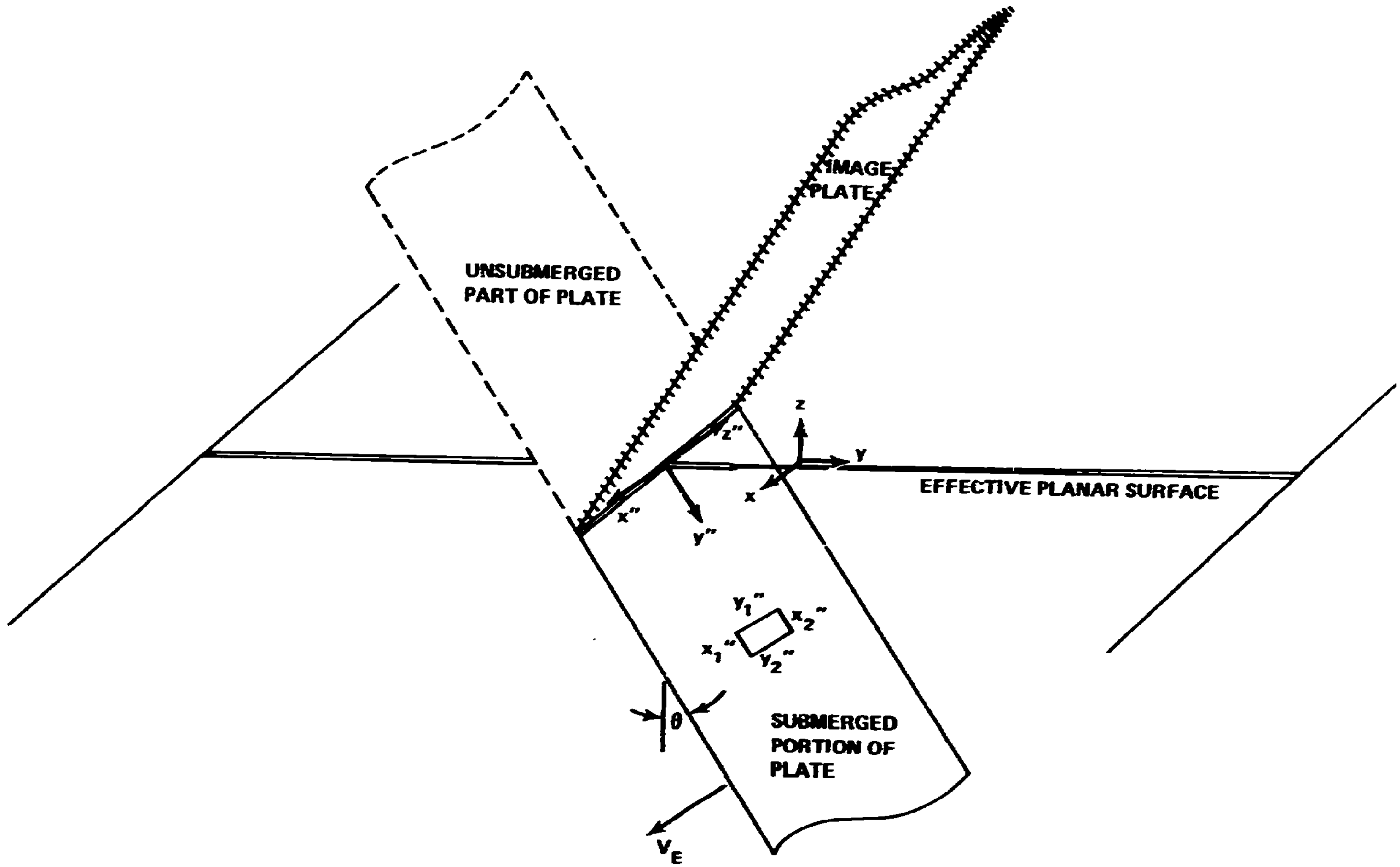

FIG. 6 PLATE OF FINITE WIDTH AND INFINITE LENGTH ENTERING THE WATER OBLIQUELY SUBJECT TO THE ASSUMED BOUNDARY CONDITIONS.

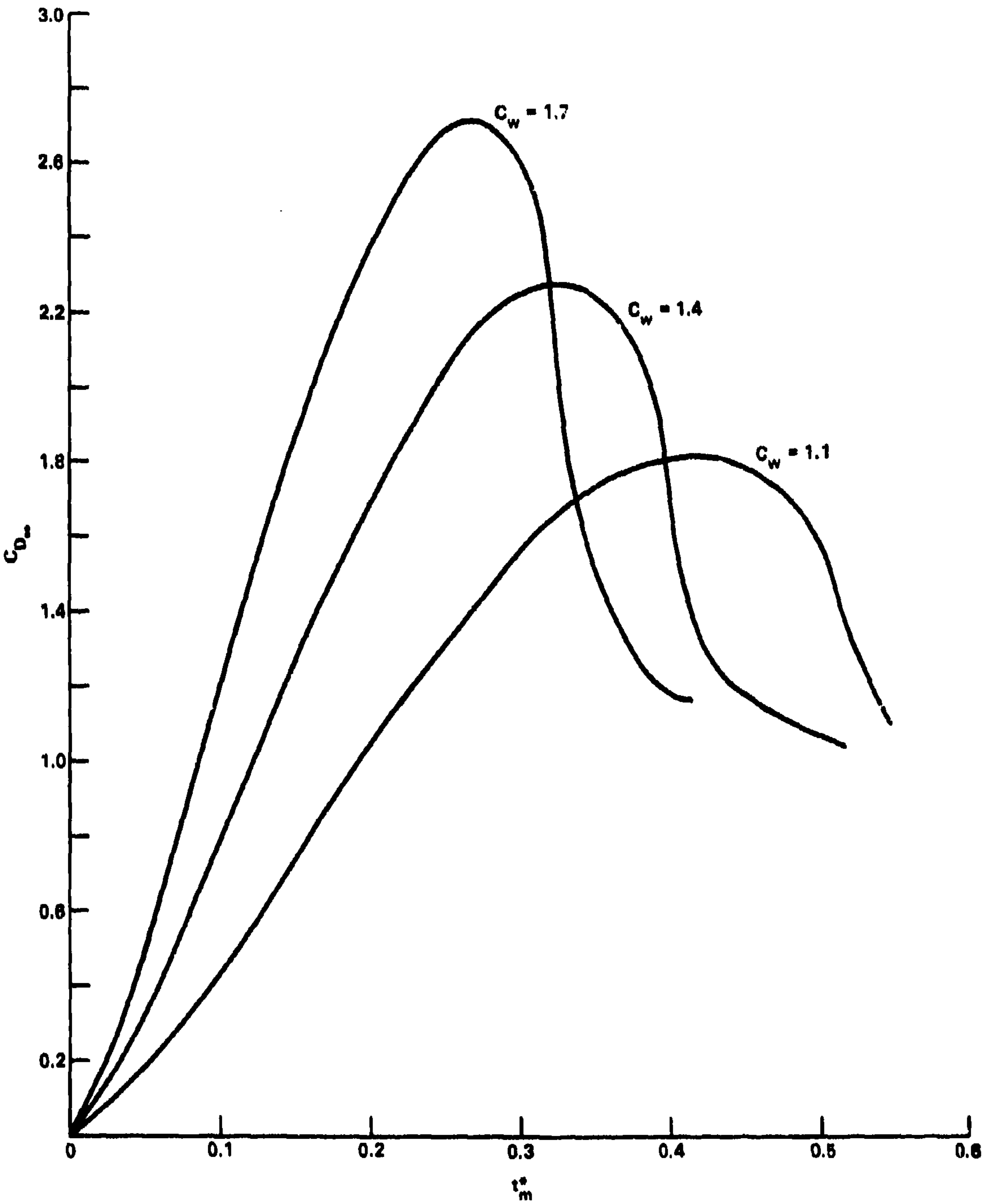

FIG. 7 DRAG OF A DISK AT AN ENTRY ANGLE OF 60 DEGREES AS A FUNCTION OF C_w.

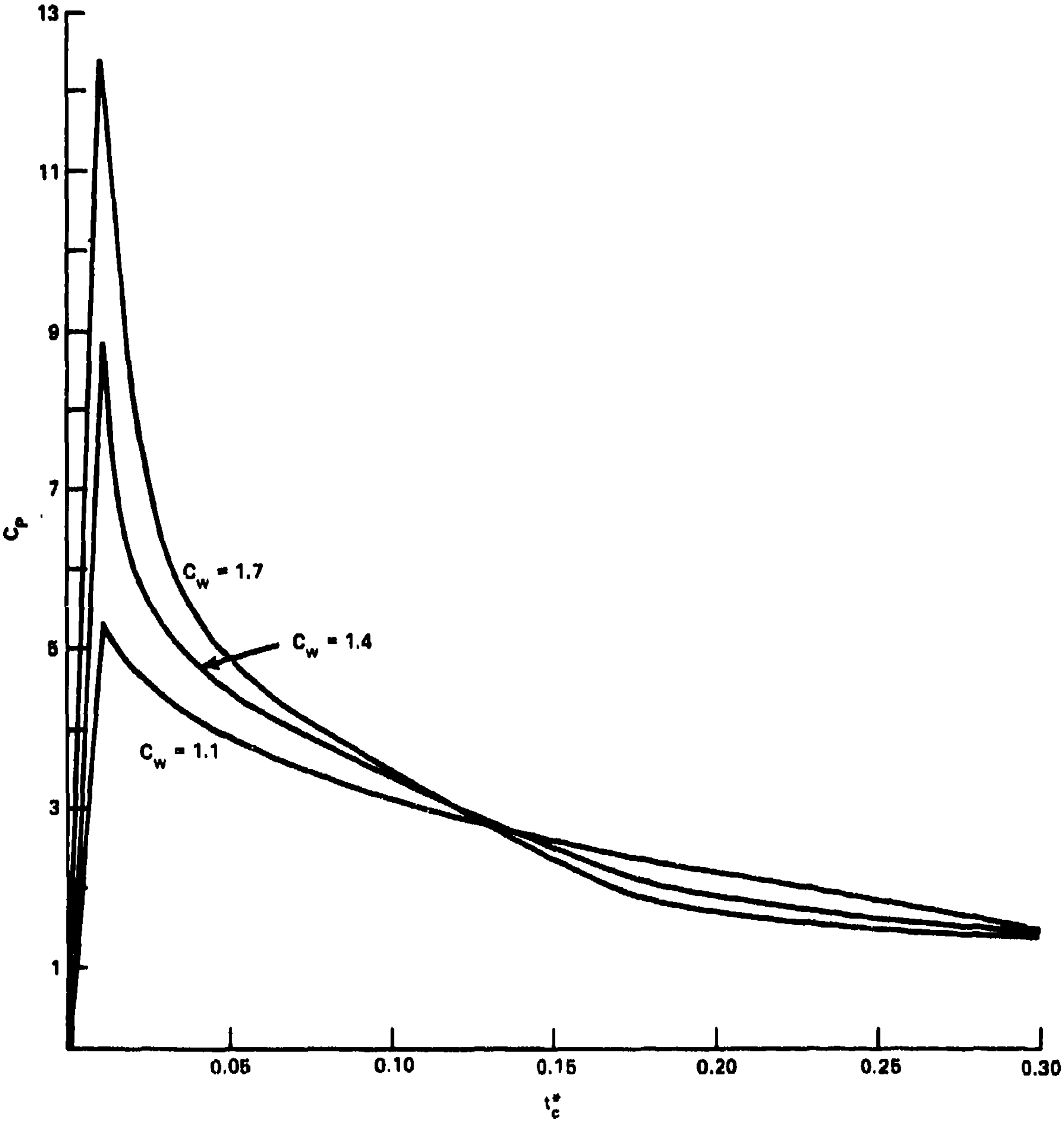

FIG. 8 PRESSURE COEFFICIENT AT THE CENTER OF A DISK CYLINDER ENTERING AT 60 DEGREES AS A FUNCTION OF C_w.

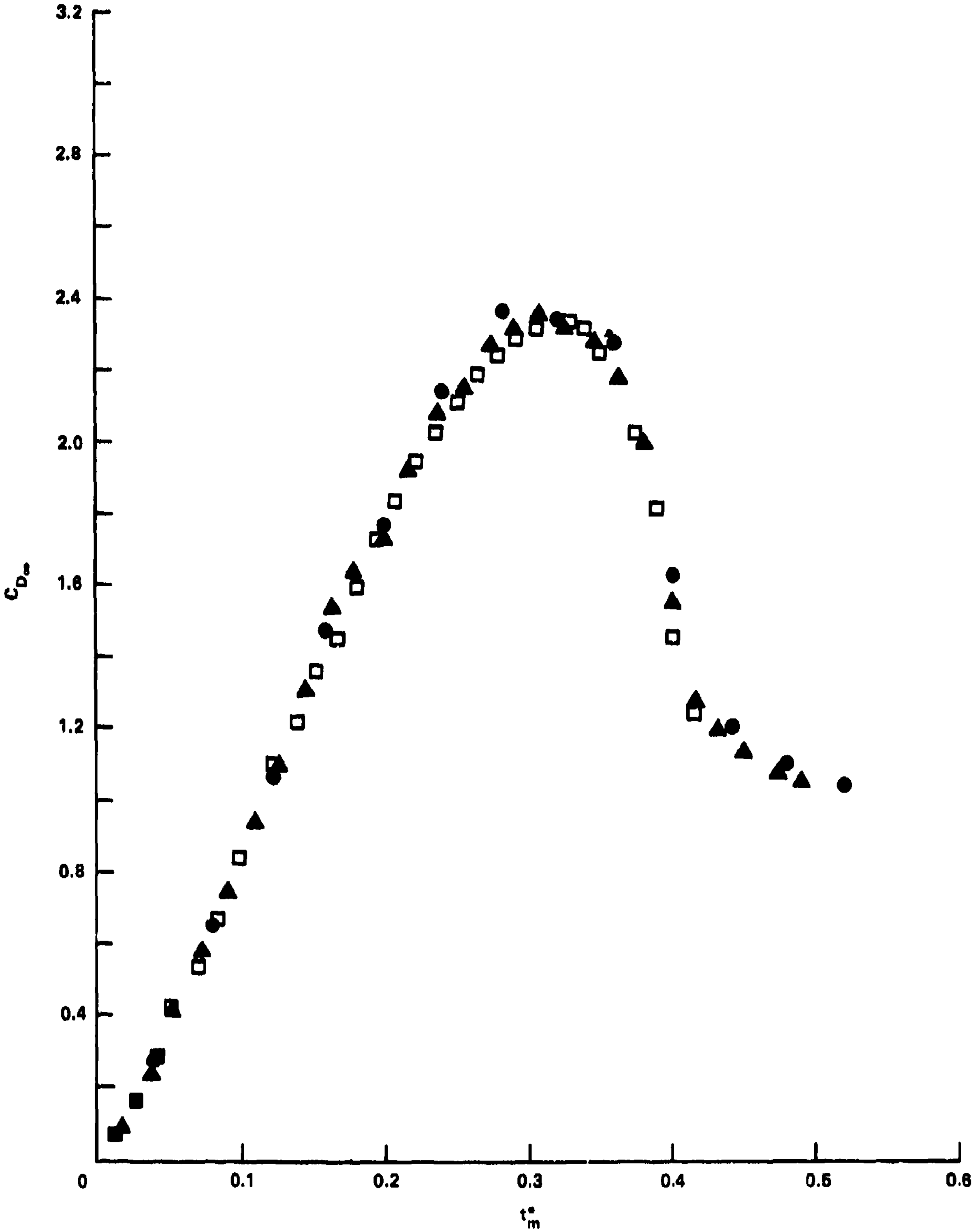

FIG. 9 THE EFFECT ON CALCULATED DRAG OF VARYING THE GRID SIZE. THE ENTRY BODY IS A DISK CYLINDER AT θ = 60 AND C_w = 1.45. ● 12 ELEMENT GRID ▲51 ELEMENT GRID □92 ELEMENT GRID.

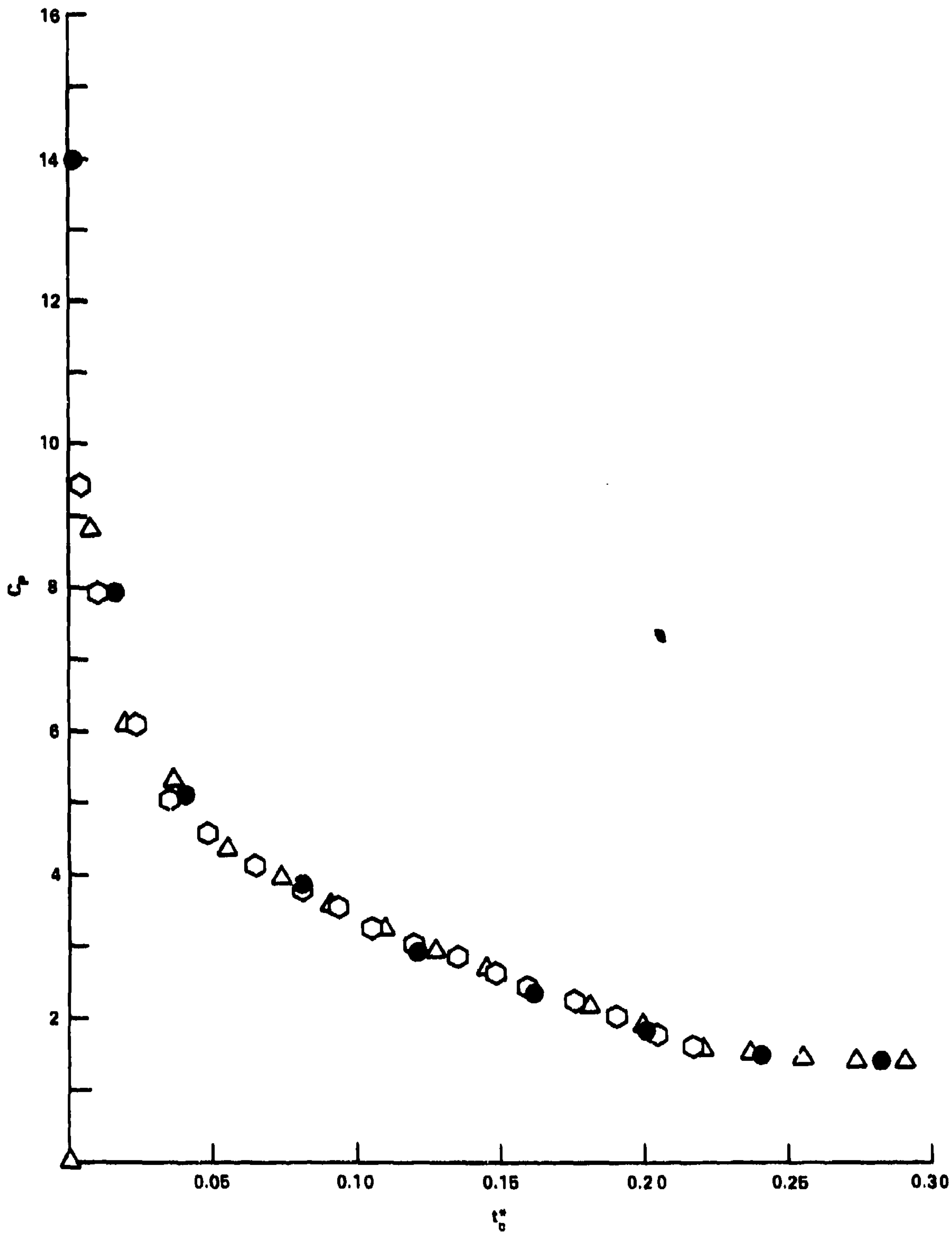

FIG. 10 THE EFFECT ON THE PRESSURE COEFFICIENT AT THE CENTER OF A DISK ENTERING OBLIQUELY AT θ = 60 OF VARIOUS GRID SIZES. ● 12 ELEMENT GRID △ 51 ELEMENT GRID ○ 92 ELEMENT GRID

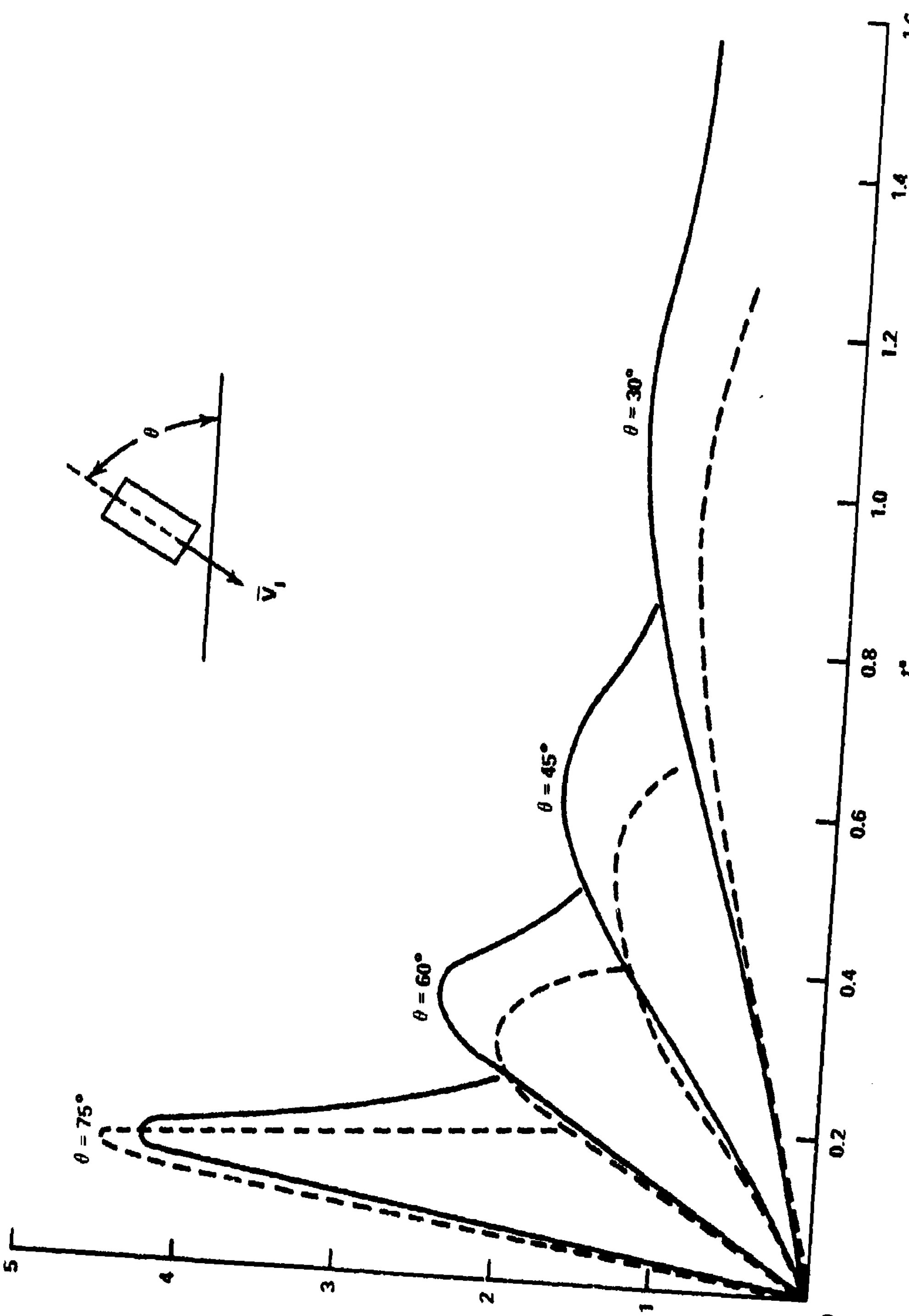

FIG. 11 PREDICTED AND MEASURED DRAG ON A DISK CYLINDER AT VARIOUS ENTRY ANGLES. —— EXPERIMENTAL DATA BY BALDWIN[13] – – – CALCULATED RESULTS WITH C_W = 1.45 AND USING A GRID COVERING BOTH THE NOSE AND AFTERBODY OF THE MODEL.

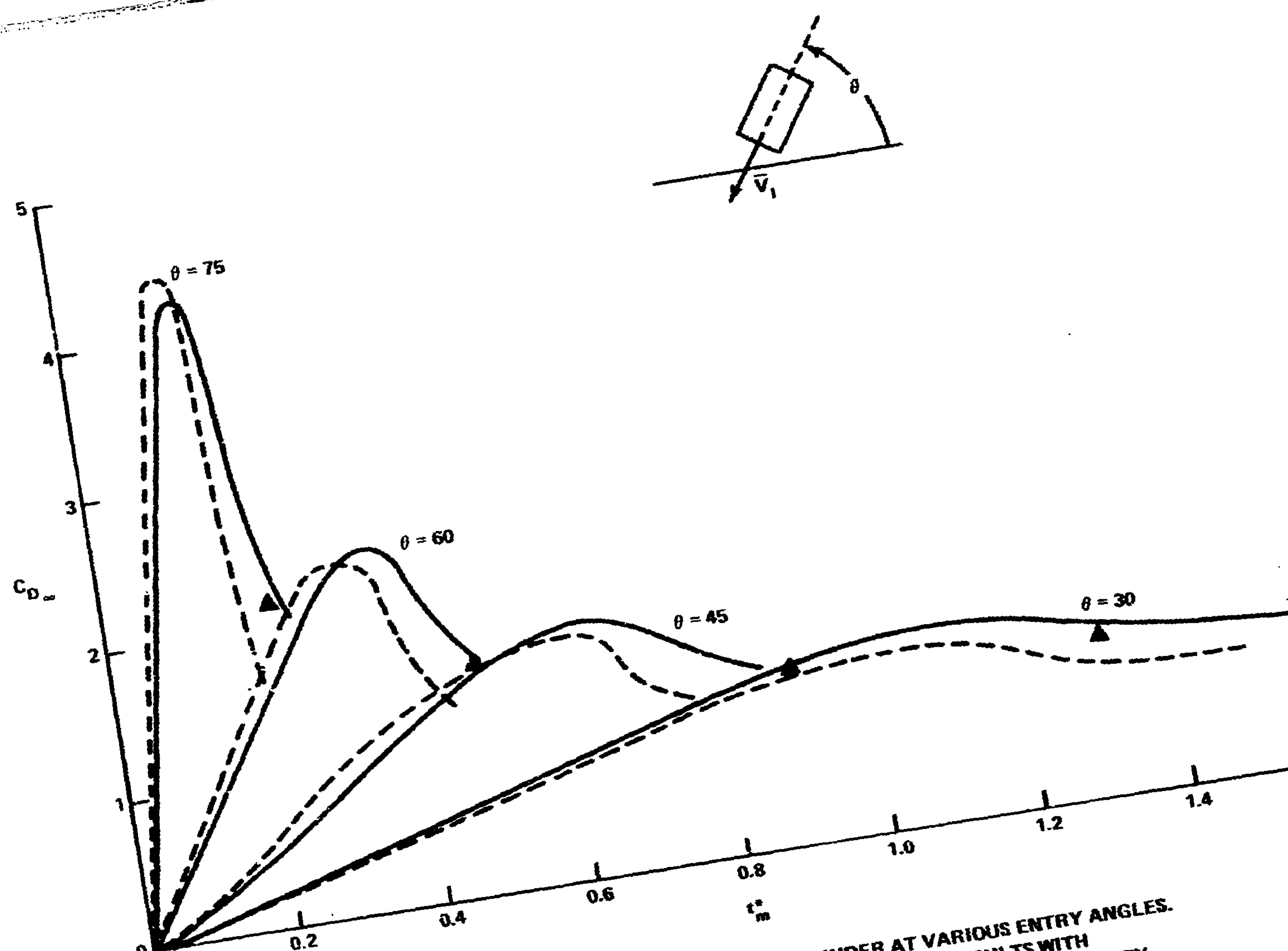

FIG. 12 PREDICTED AND MEASURED DRAG ON A DISK CYLINDER AT VARIOUS ENTRY ANGLES. ——— EXPERIMENTAL DATA BY BALDWIN[13] – – CALCULATED RESULTS WITH C_W = 1.45 AND USING A GRID COVERING ONLY THE NOSE OF THE MODEL. ▲CAVITY SHAPE MODELED WITH NO LOAD ELEMENTS.

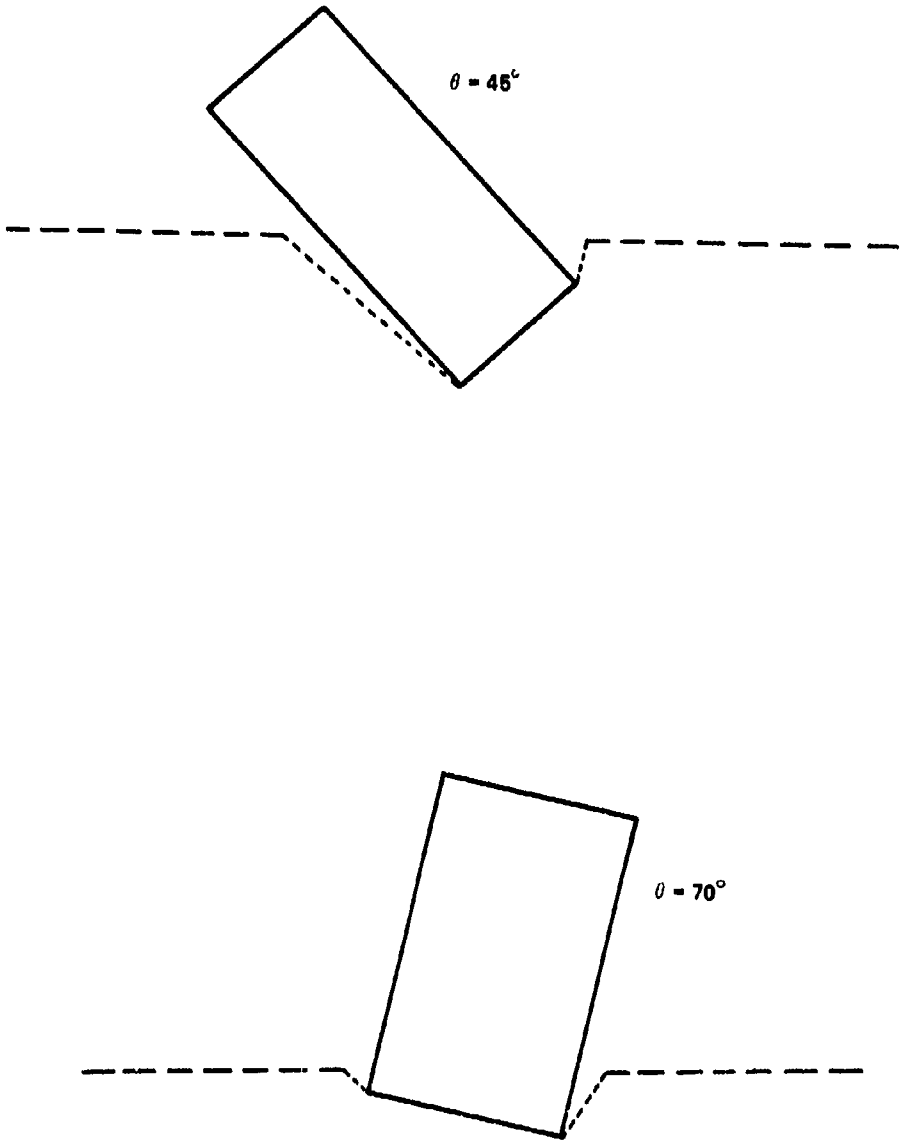

FIG. 13 PROFILE OF THE CAVITY ABOUT A DISK CYLINDER AT SEVERAL ENTRY ANGLES CALCULATED USING NO LOAD ELEMENTS. — — EFFECTIVE PLANAR SURFACE - - - WATER-CAVITY INTERFACE.

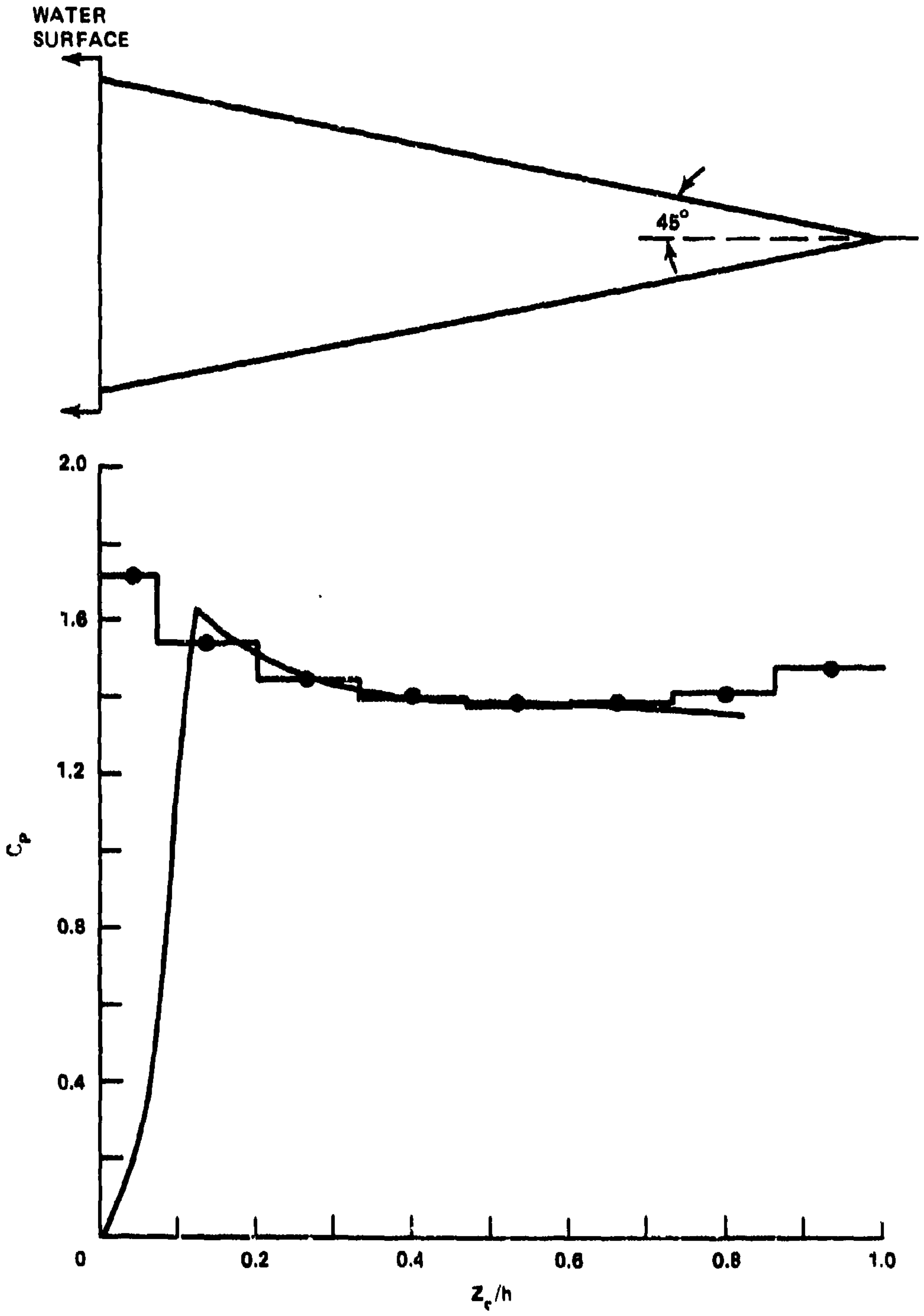

FIG. 14 PRESSURE DISTRIBUTION ON A 45 DEGREE HALF-ANGLE CONE ENTERING VERTICALLY. THE SHADED CIRCLES REPRESENT THE CALCULATED VALUES AT ELEMENT CENTRIODS WHILE THE HORIZONTAL LINES INDICATE THE EXTENT OF EACH ELEMENT. THE ELEMENT ADJACENT TO THE WATER SURFACE IS MODIFIED. C_w = 1.45. THE SOLID CURVE IS EXPERIMENTAL DATA BY BALDWIN[13].

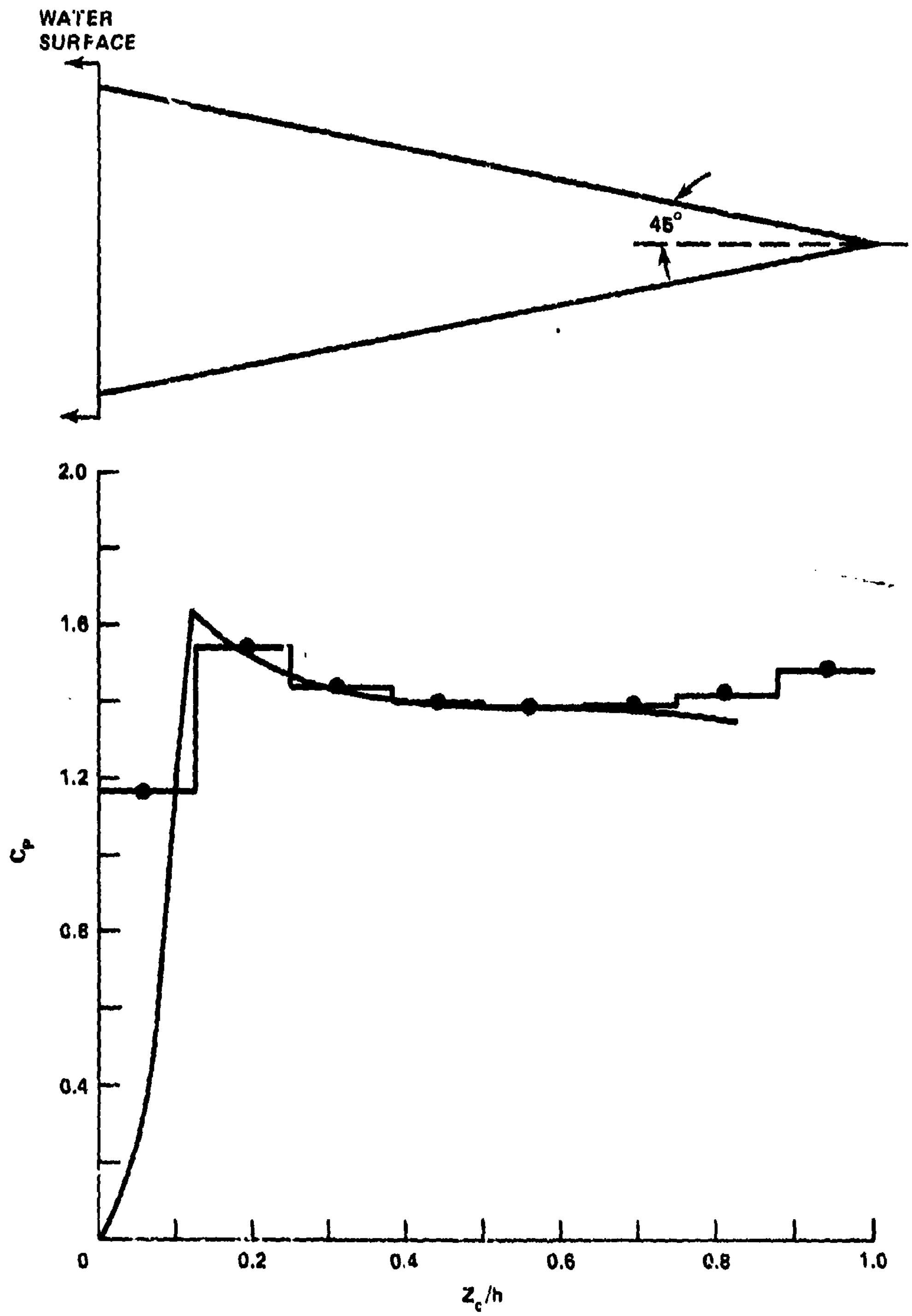

FIG. 15 PRESSURE DISTRIBUTION ON A 45 DEGREE HALF ANGLE CONE ENTERING VERTICALLY. THE SHADED CIRCLES REPRESENT THE CALCULATED VALUES AT ELEMENT CENTROIDS WHILE THE HORIZONTAL LINES INDICATE THE EXTEND OF EACH ELEMENT. THE SOLID CURVE IS EXPERIMENTAL DATA BY BALDWIN[13]. THE ELEMENT ADJACENT TO THE WATER SURFACE IS NOT MODIFIED. $C_w = 1.45$.

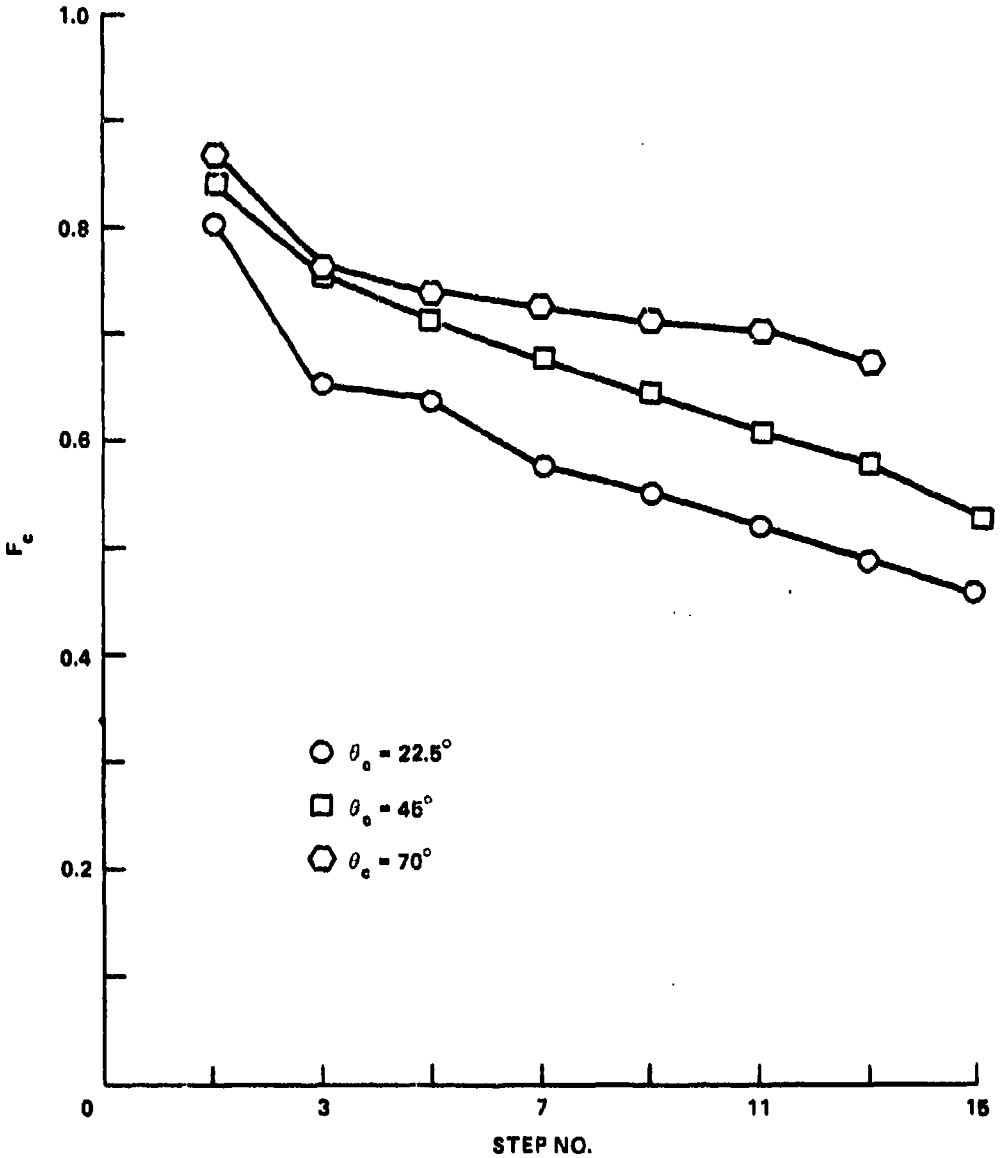

FIG. 16 MODIFIED ELEMENT CORRECTION FACTOR AS A FUNCTION OF STEP NUMBER.

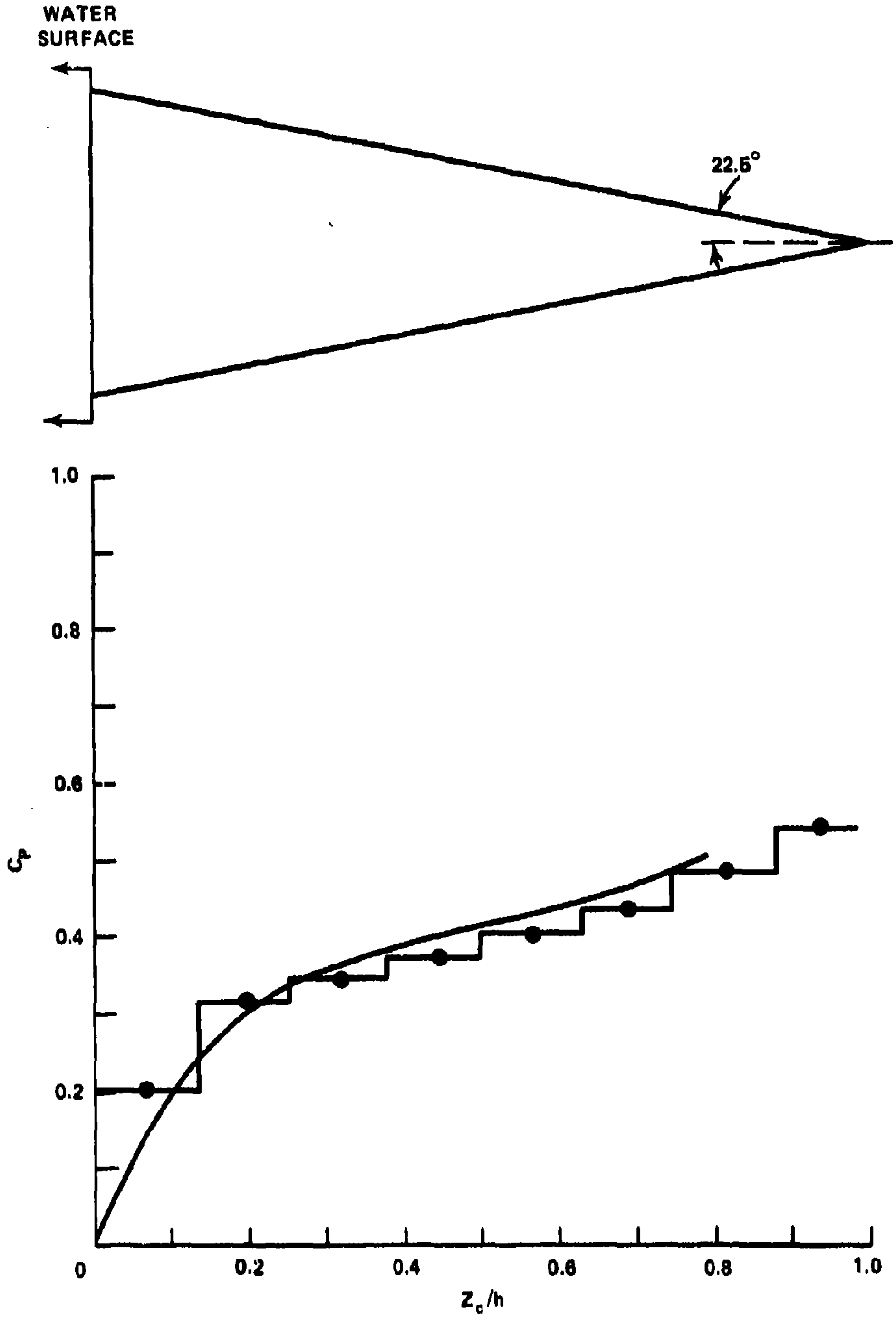

FIG. 17 PRESSURE DISTRIBUTION ON A 22.5 DEGREE HALF-ANGLE CONE ENTERING VERTICALLY THE SHADED CIRCLES REPRESENT THE CALCULATED VALUE AT EACH ELEMENT CENTROID. WHILE THE HORIZONTAL LINES INDICATE THE EXTENT OF EACH ELEMENT. THE SOLID CURVE IS EXPERIMENTAL DATA BY BALDWIN[13], $C_w = 1.14$.

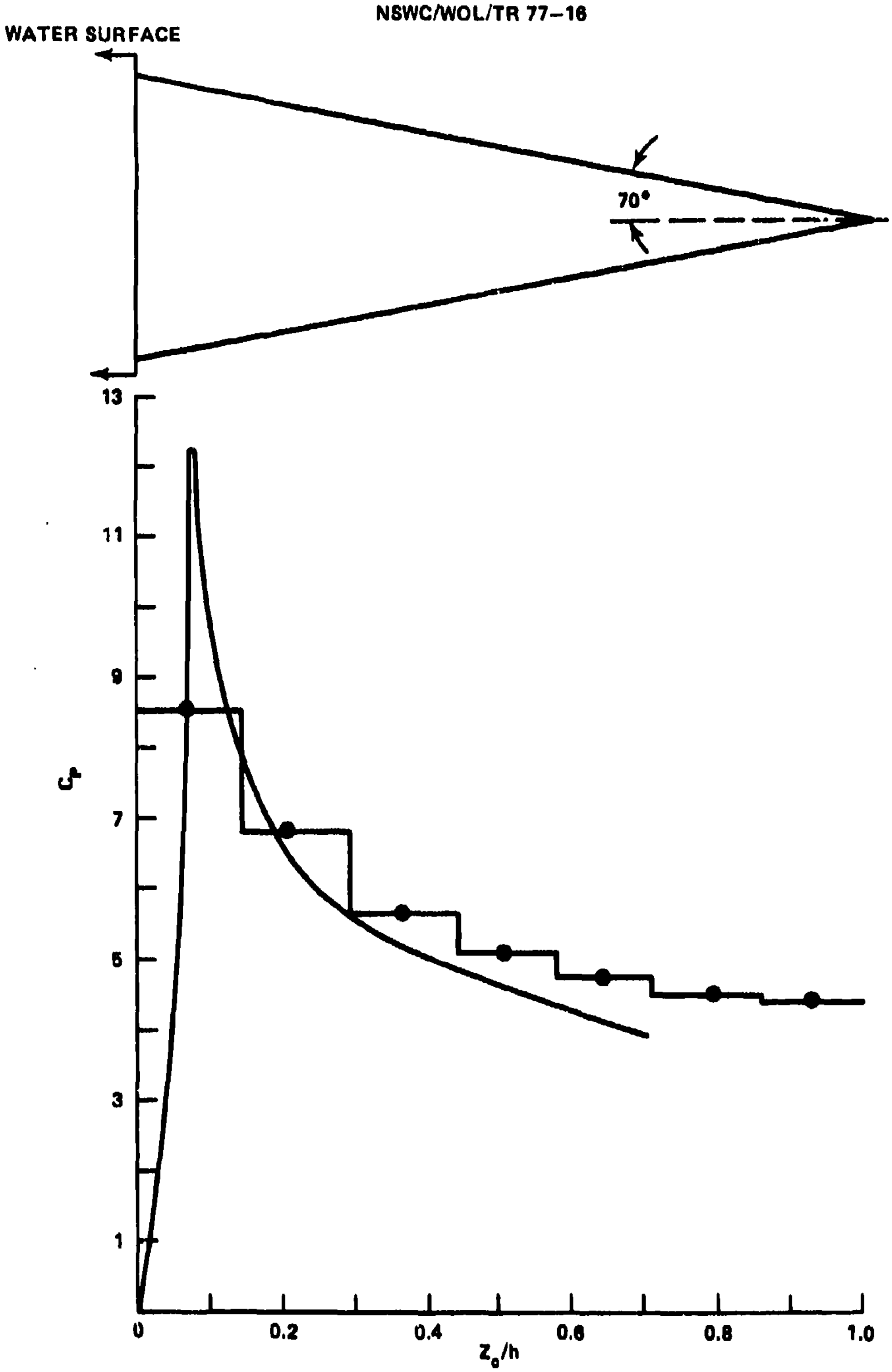

FIG. 18 PRESSURE DISTRIBUTION ON A 70 DEGREE HALF-ANGLE CONE ENTERING VERTICALLY. THE SHADED CIRCLES REPRESENT THE CALCULATED VALUE AT EACH ELEMENT CENTROID WHILE THE HORIZONTAL LINES INDICATE THE EXTENT OF EACH ELEMENT. THE SOLID CURVE IS EXPERIMENTAL DATA BY BALDWIN[13], $C_w = 1.39$.

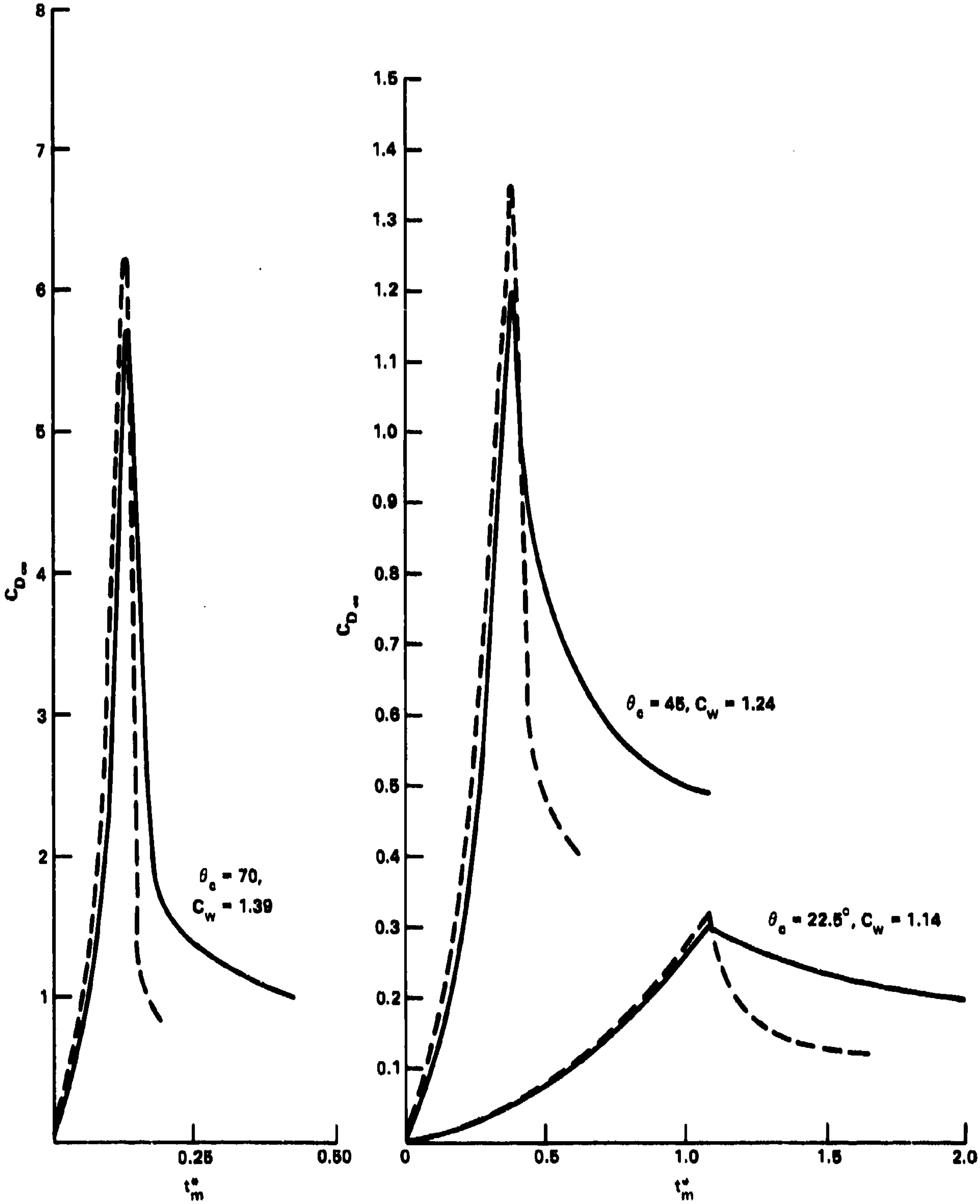

FIG. 19 CALCULATED AND MEASURED DRAG ON VERTICALLY ENTERING CONES.
——— MEASURED BY BALDWIN[14] – – – CALCULATED.

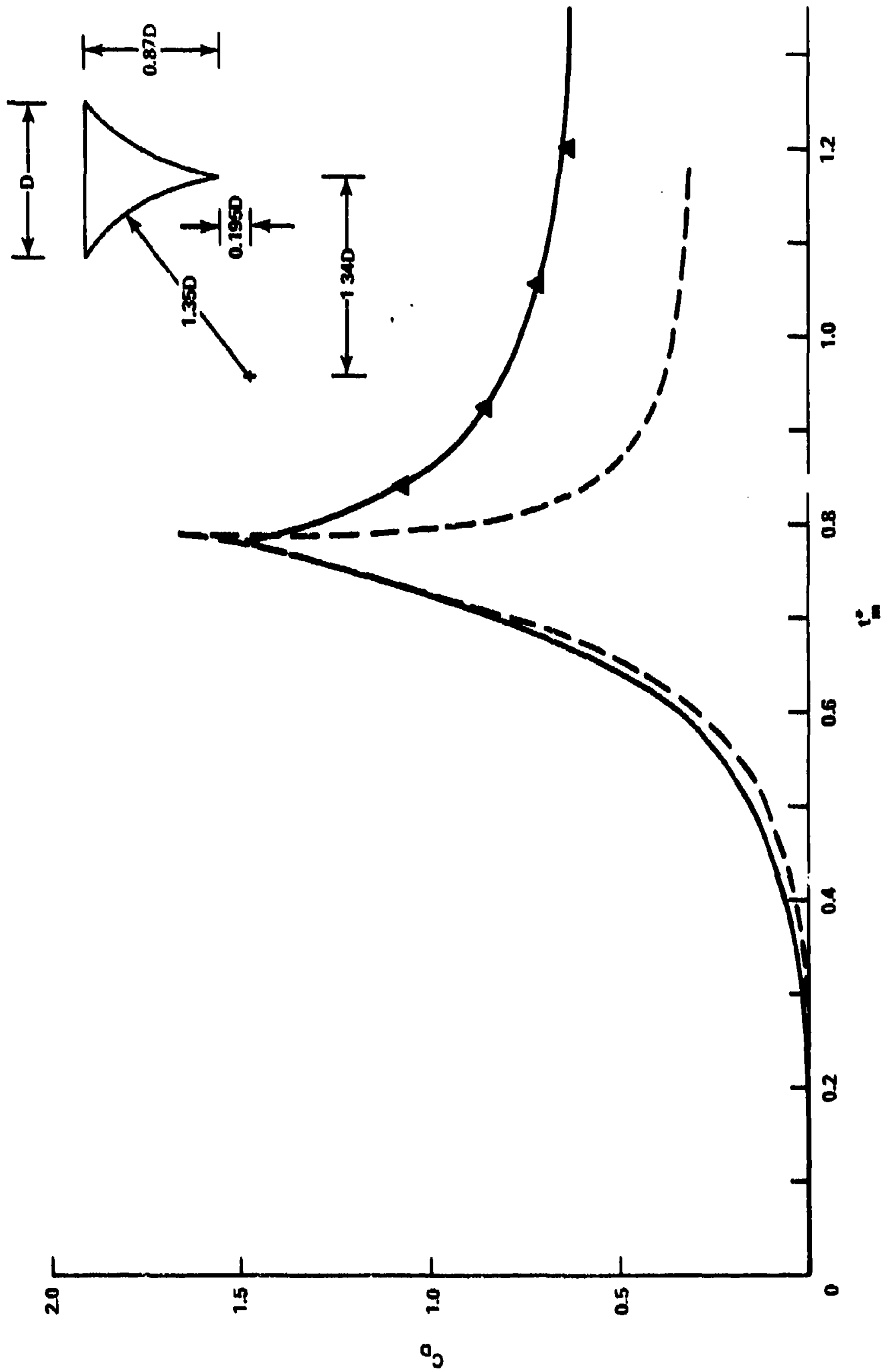

FIG. 20 CALCULATED AND MEASURED DRAG ON A VERTICALLY ENTERING CUSP. — — CALCULATED.
——— MEASURED[16] ▲ CALCULATED WITH A CAVITY SIMULATED BY NO LOAD ELEMENTS.

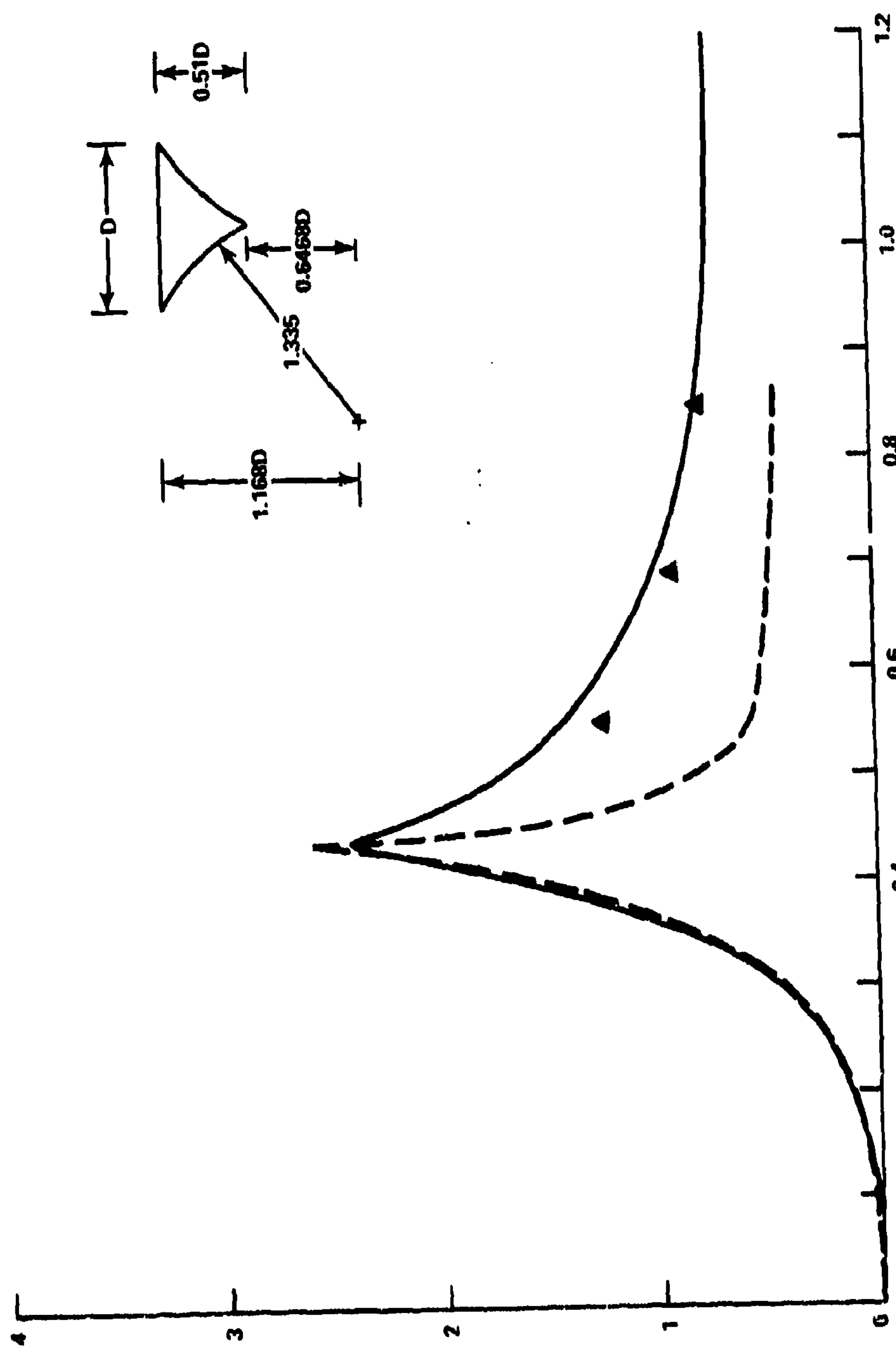

FIG. 21 CALCULATED AND MEASURED DRAG ON A VERTICALLY ENTERING CUSP. – – CALCULATED
—— MEASURED[16] ▲CALCULATED WITH A CAVITY SIMULATED BY NO LOAD ELEMENTS.

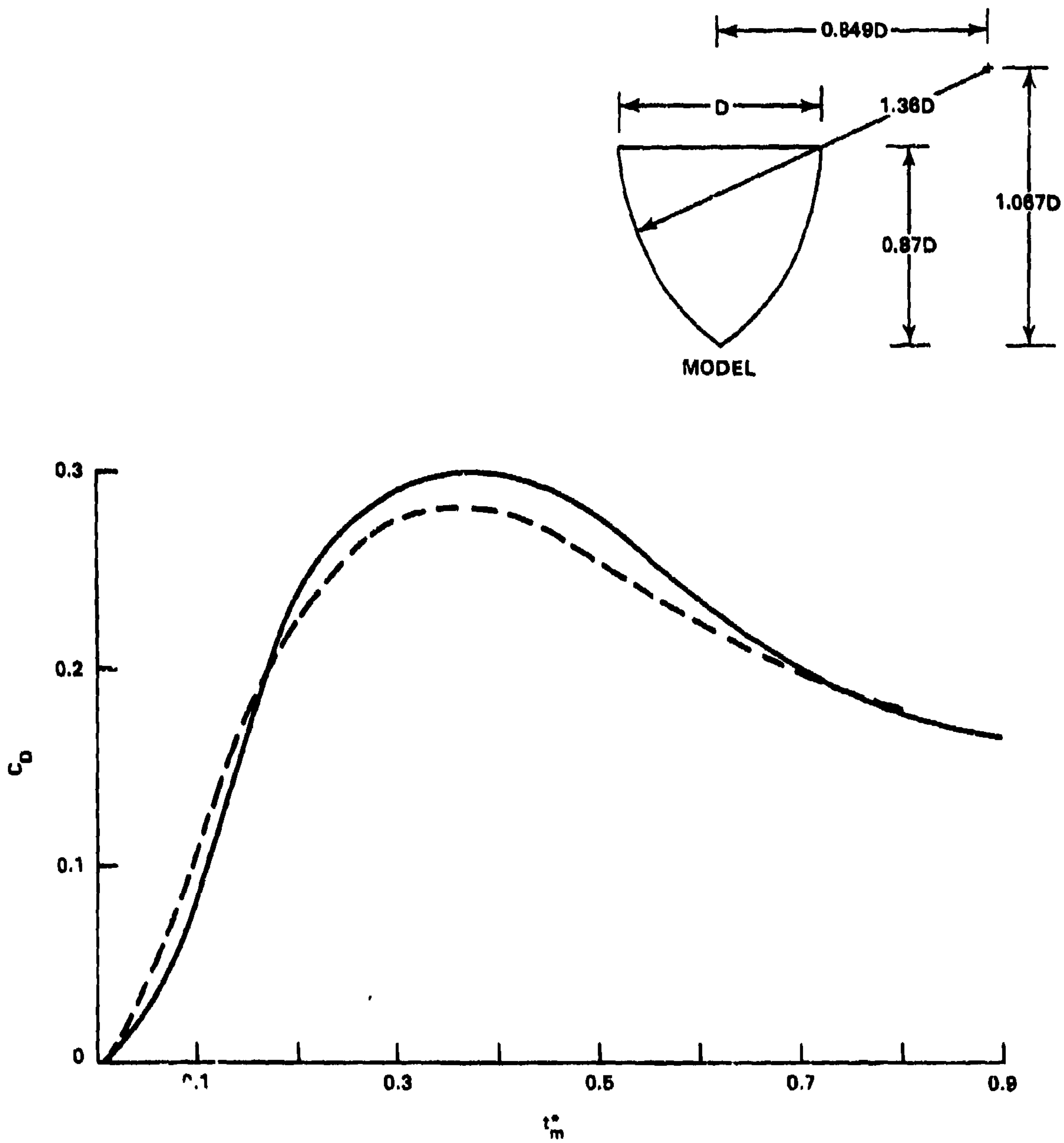

FIG. 22 CALCULATED AND MEASURED DRAG ON A VERTICALLY ENTERING OGIVE.
– – CALCULATED —— MEASURED[16].

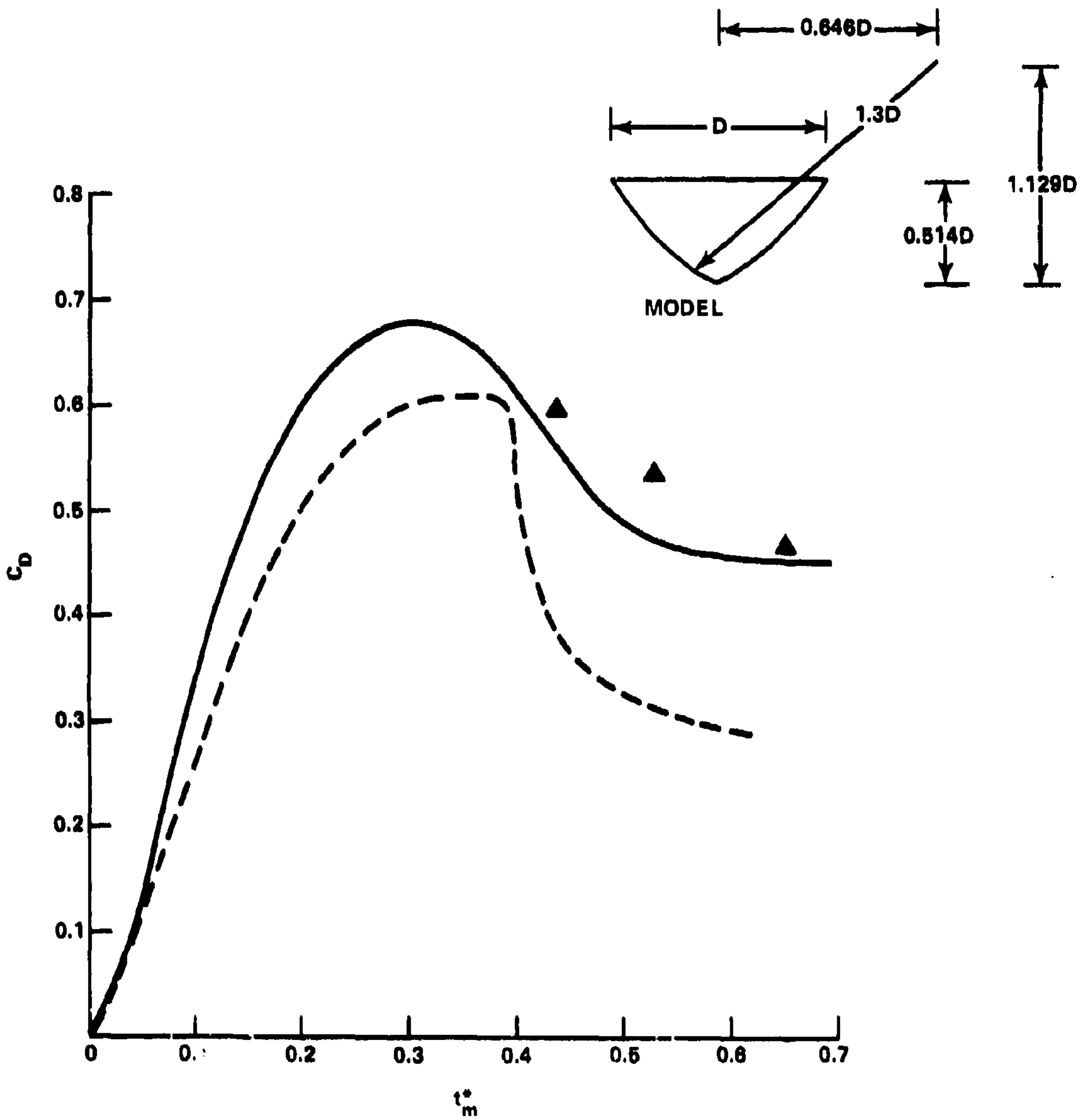

FIG. 23 CALCULATED AND MEASURED DRAG ON A VERTICALLY ENTERING OGIVE. — — CALCULATED —— MEASURED[16]. ▲CALCULATED WITH A CAVITY SIMULATED BY NO LOAD ELEMENTS.

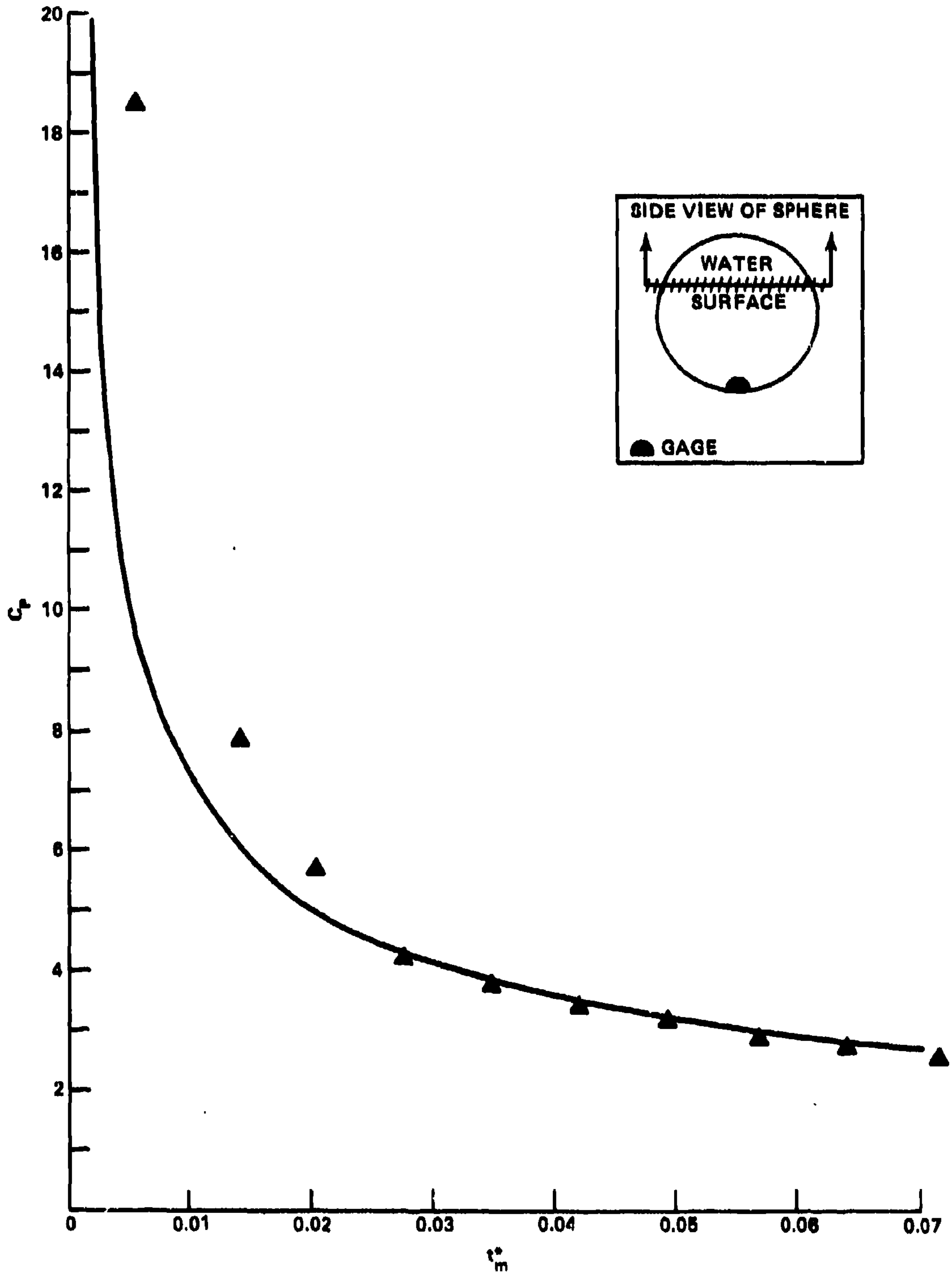

FIG. 24 CALCULATED AND MEASURED STAGNATION PRESSURE ON A SPHERE ENTERING VERTICALLY AT 23.5 FT/SEC. —— MEASURED BY NISEWANGER[17] ▲COMPUTED USING A C_W VALUE DEFINED BY EQUATION (26).

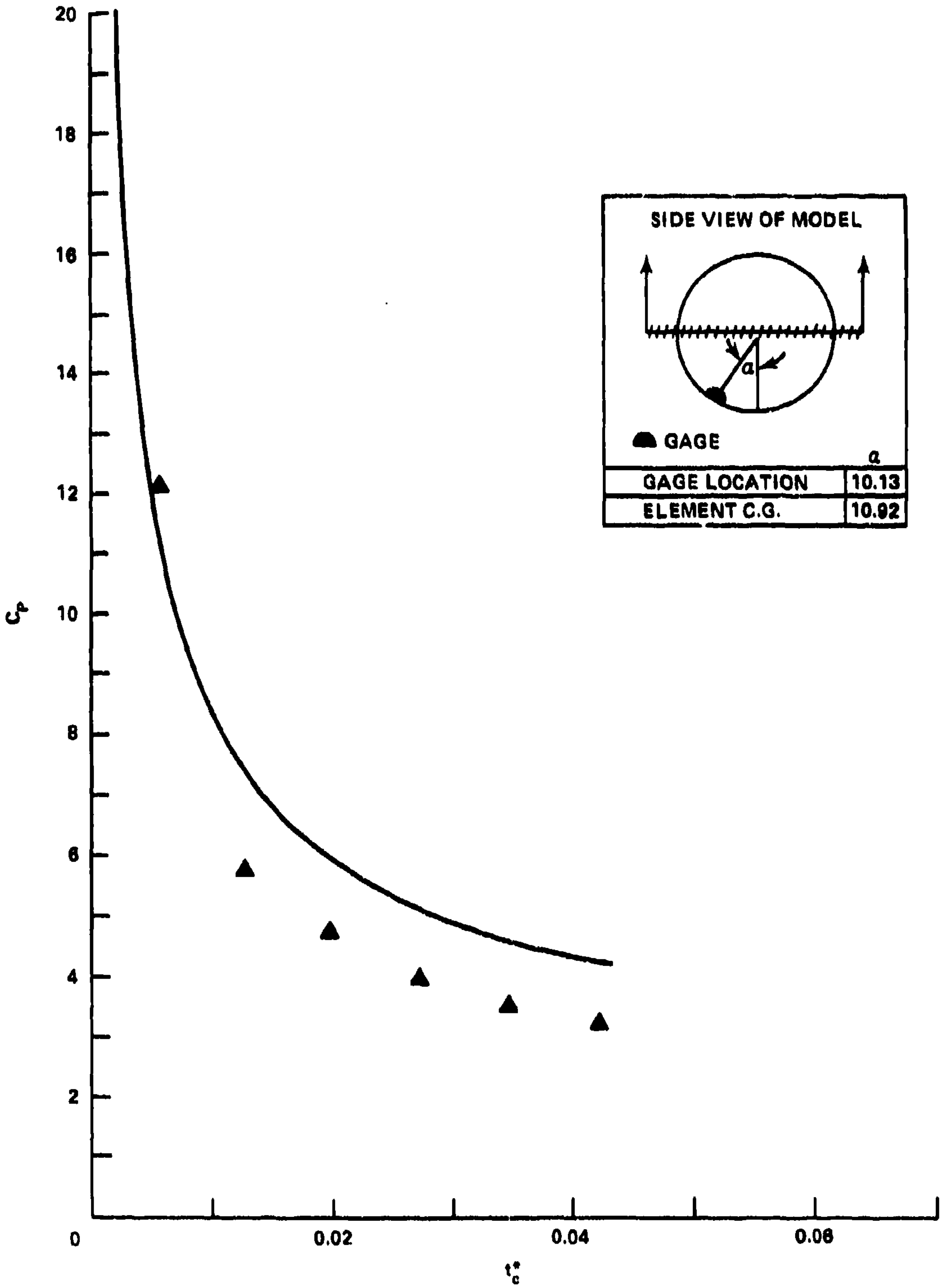

FIG. 25 CALCULATED AND MEASURED PRESSURE COEFFICIENT ON A VERTICALLY ENTERING SPHERE. —— MEASURED BY NISEWANGER[17] ▲ CALCULATED USING THE C_W FACTOR DEFINED BY EQUATION (26).

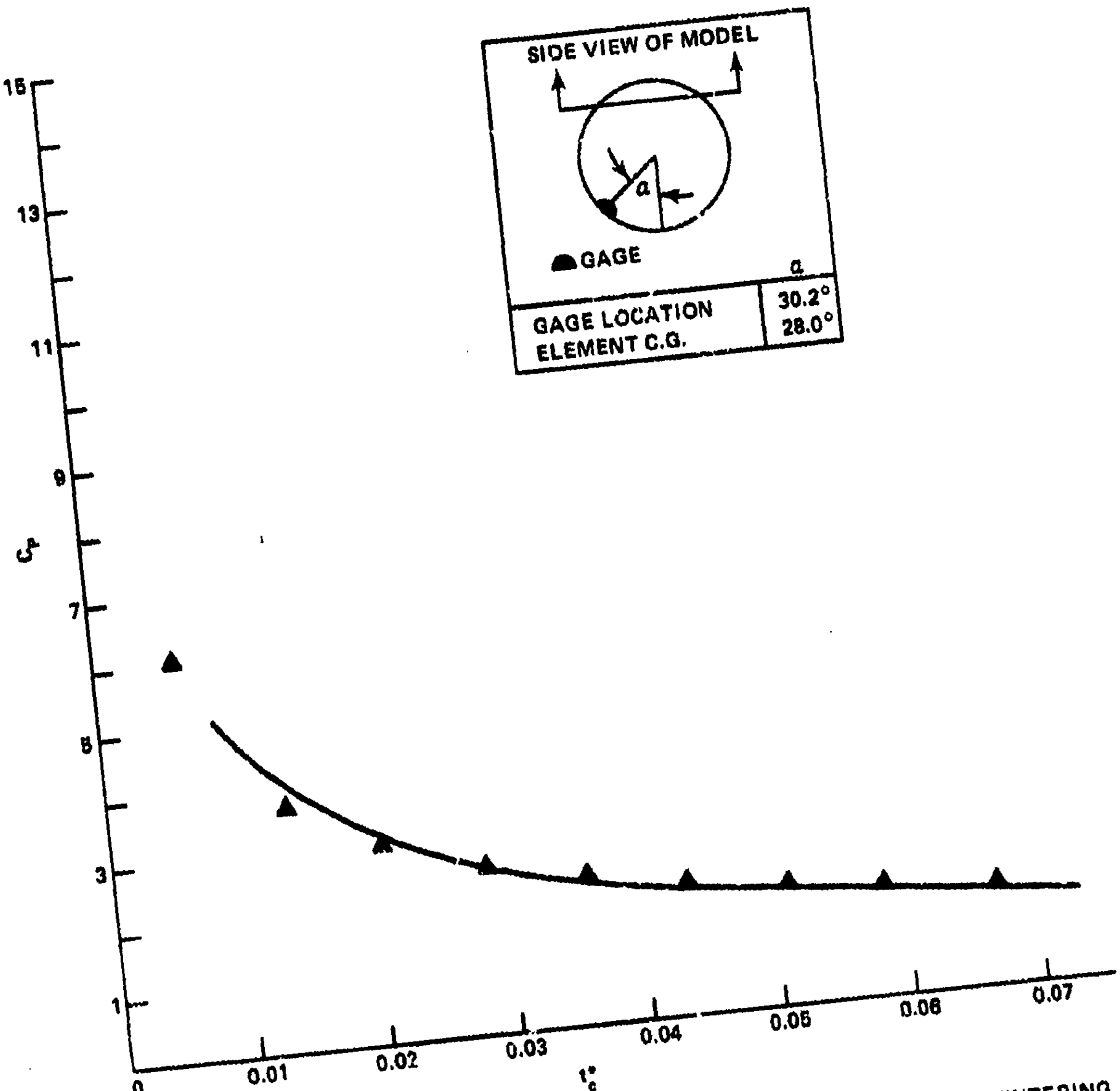

FIG. 26 CALCULATED AND MEASURED PRESSURE COEFFICIENT ON A VERTICALLY ENTERING SPHERE. —— MEASURED BY NISEWANGER[17] ▲ CALCULATED USING THE C_W FACTOR DEFINED IN EQUATION (25).

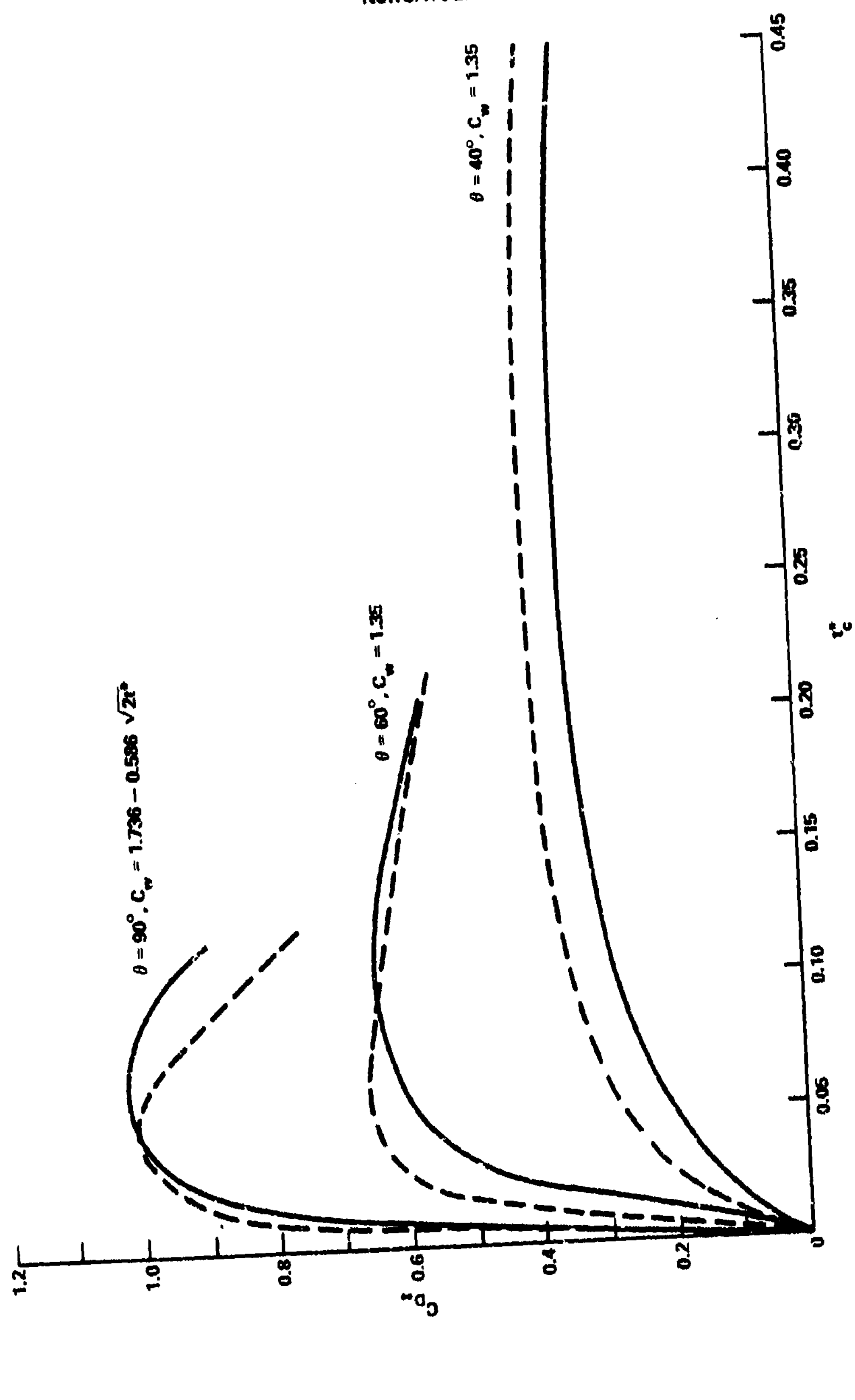

FIG. 27 CALCULATED AND MEASURED DRAG ON A SPHERE AT VARIOUS ENTRY ANGLES. ——— MEASURED 2.17 – – – CALCULATED.

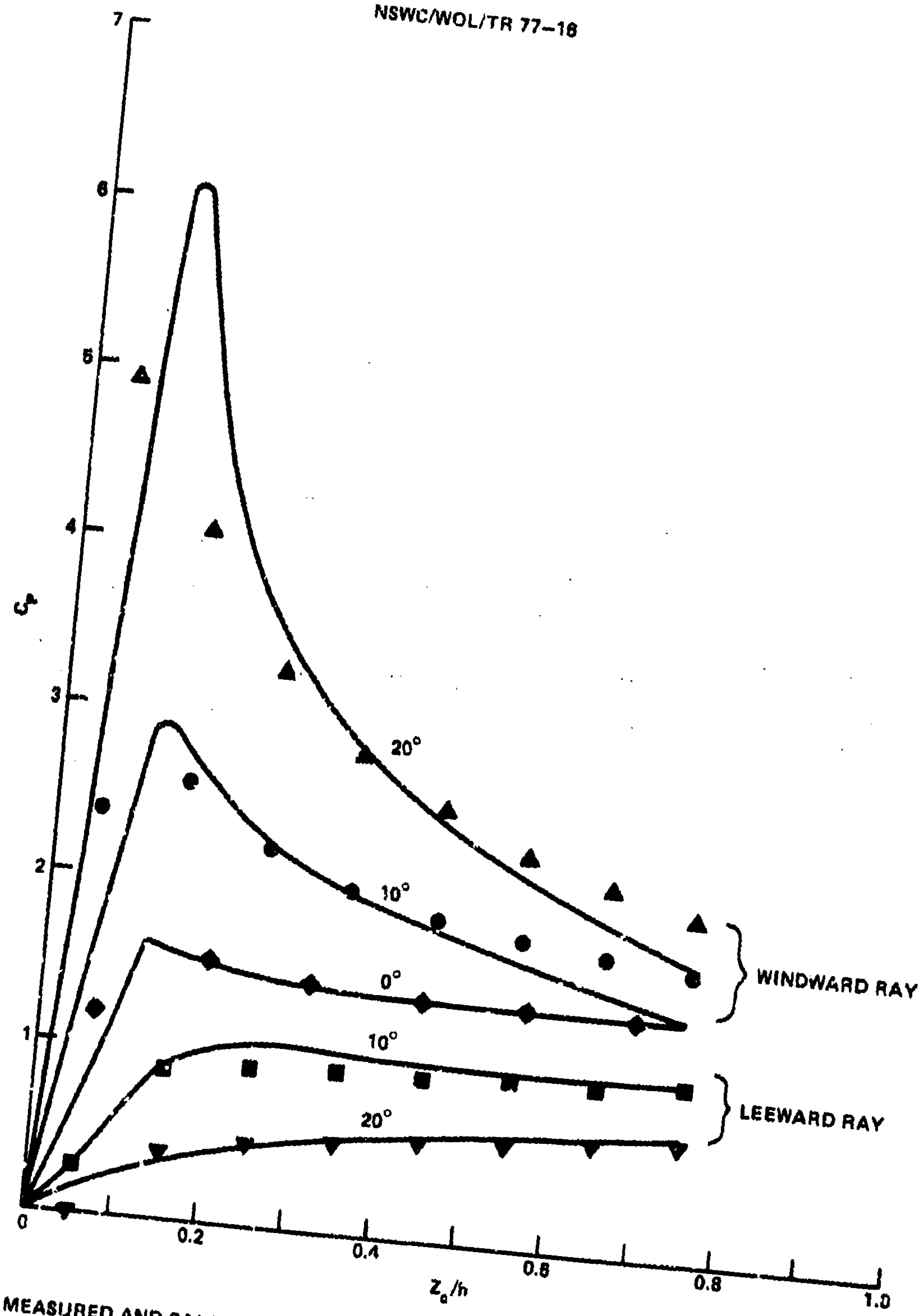

FIG. 28 MEASURED AND CALCULATED PRESSURE DISTRIBUTION ON A VERTICALLY ENTERING 45 DEGREE HALF-ANGLE CONE AT 0, 10, 20 DEGREE INCIDENCE. ——— UNPUBLISHED EXPERIMENTAL DATA BY BALDWIN. SOLID SYMBOLS ARE CALCULATIONS.

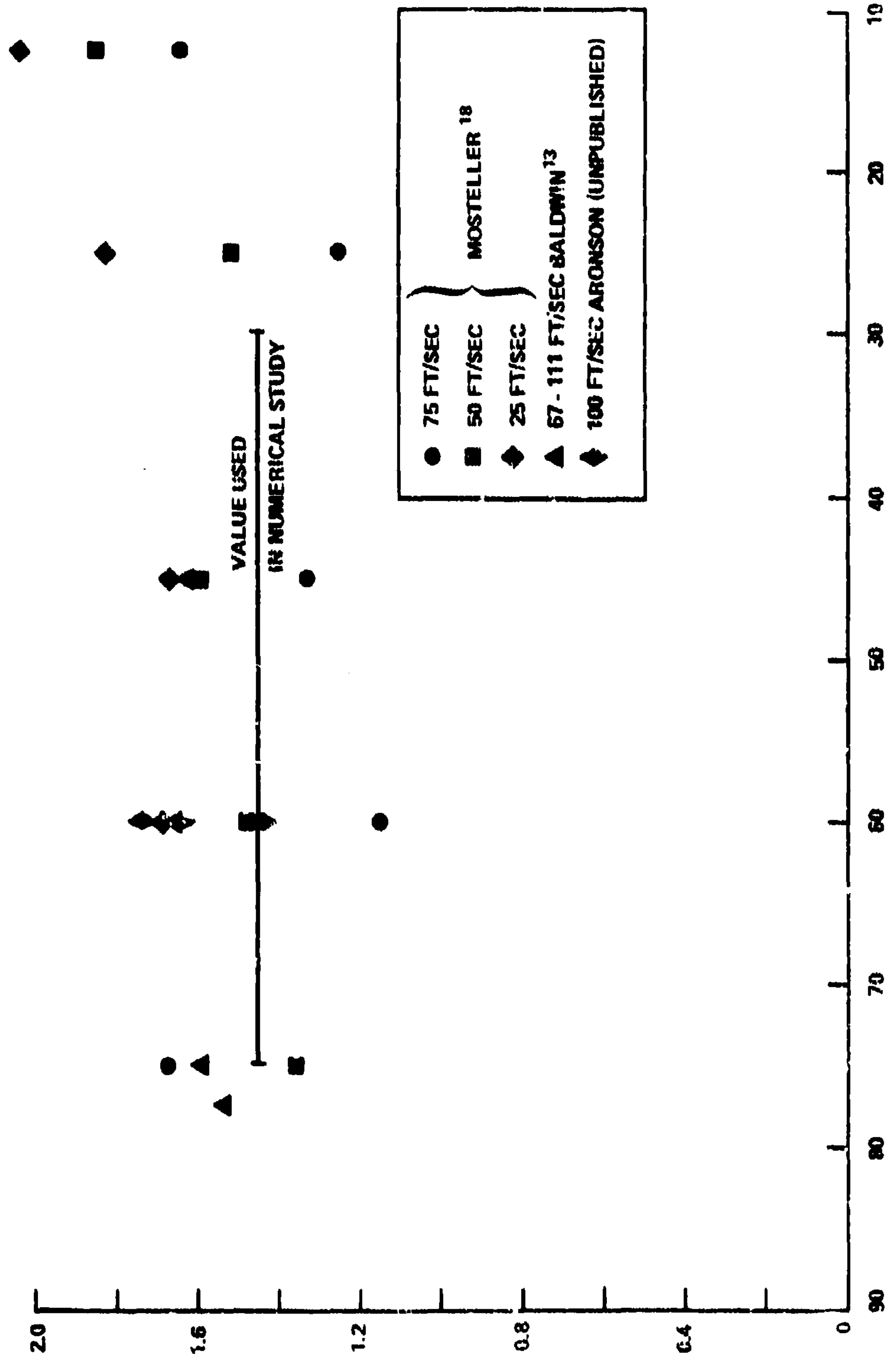

FIG. 29 EXPERIMENTALLY DETERMINED VALUES OF C_W FOR THE OBLIQUE ENTRY OF A DISK CYLINDER

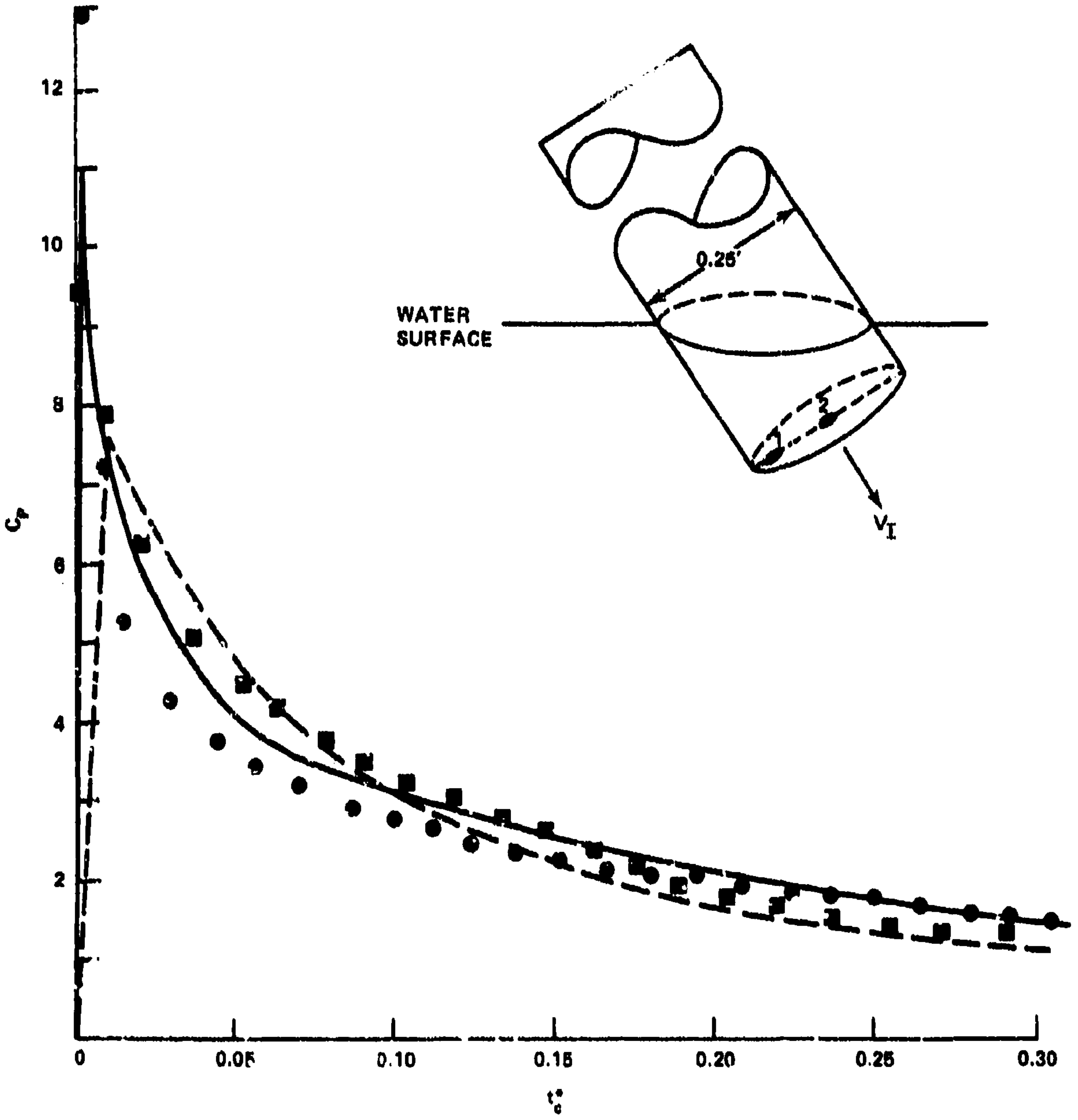

FIG. 30 CALCULATED AND MEASURED PRESSURE-TIME HISTORIES AT TWO DIFFERENT POSITIONS ON THE SURFACE OF A DISK CYLINDER, θ = 60 AND V_I = 100 FT/SEC. ——— MEASURED AT POSITION 1 (r = 0.098 β = 4°) ● CALCULATED AT POSITION 1, – – – MEASURED AT POSITION 2 (r = 0) ■ CALCULATED AT POSITION 2. MEASUREMENTS BY ARONSON.

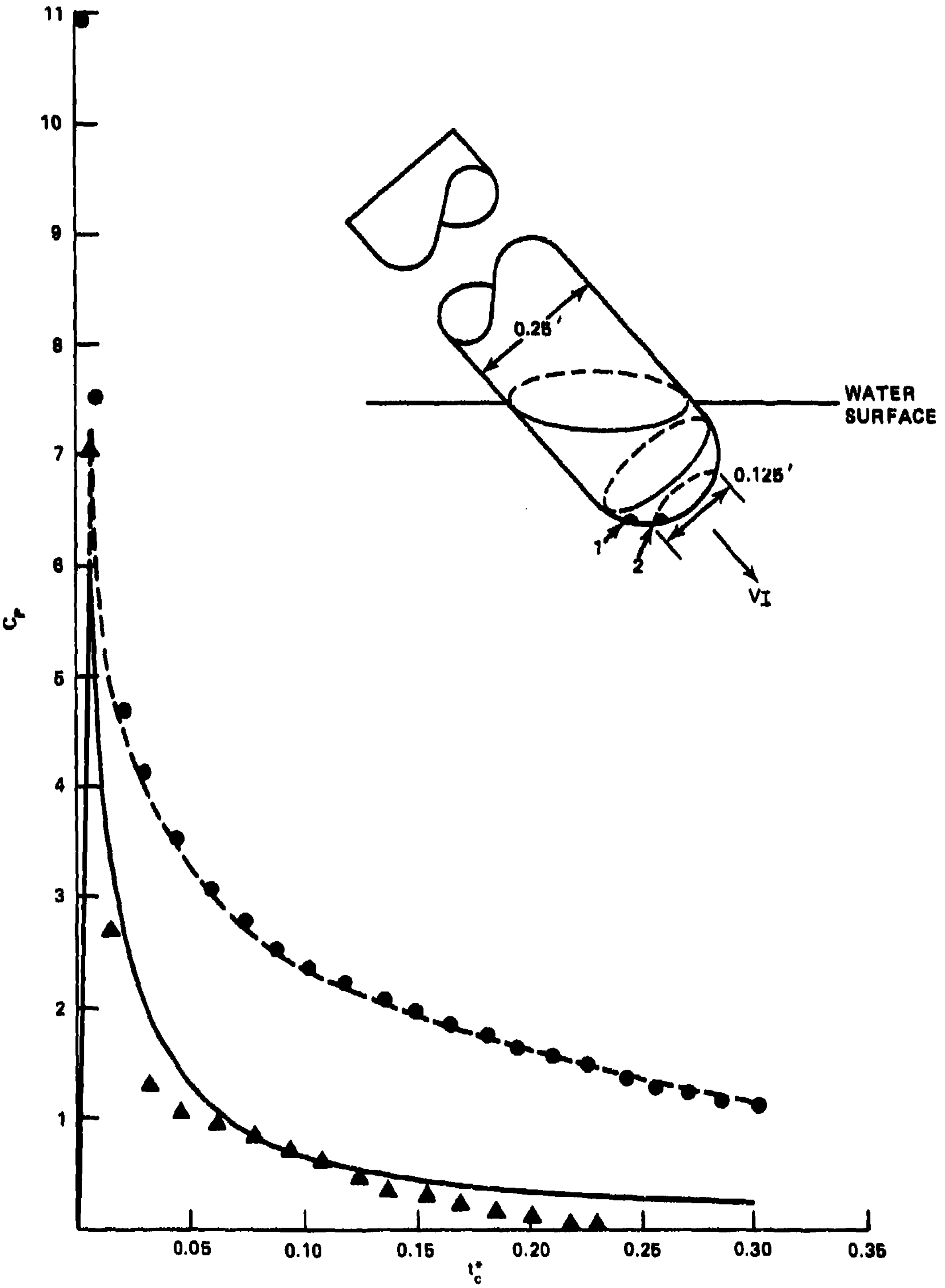

FIG. 31 CALCULATED AND MEASURED PRESSURE-TIME HISTORIES AT TWO DIFFERENT POSITIONS ON THE SURFACE AT AN OGIVE CYLINDER, θ = 60 DEGREES AND V_I = 100 FT/SEC. ——— MEASURED AT POSITION 1 (r = 0.112', β = 9.5°) ▲CALCULATED AT POSITION 1. – – – MEASURED AT POSITION 2 (r = 0.063', β = 5.5°) ●CALCULATED AT POSITION 2. MEASUREMENTS ARE BY ARONSON

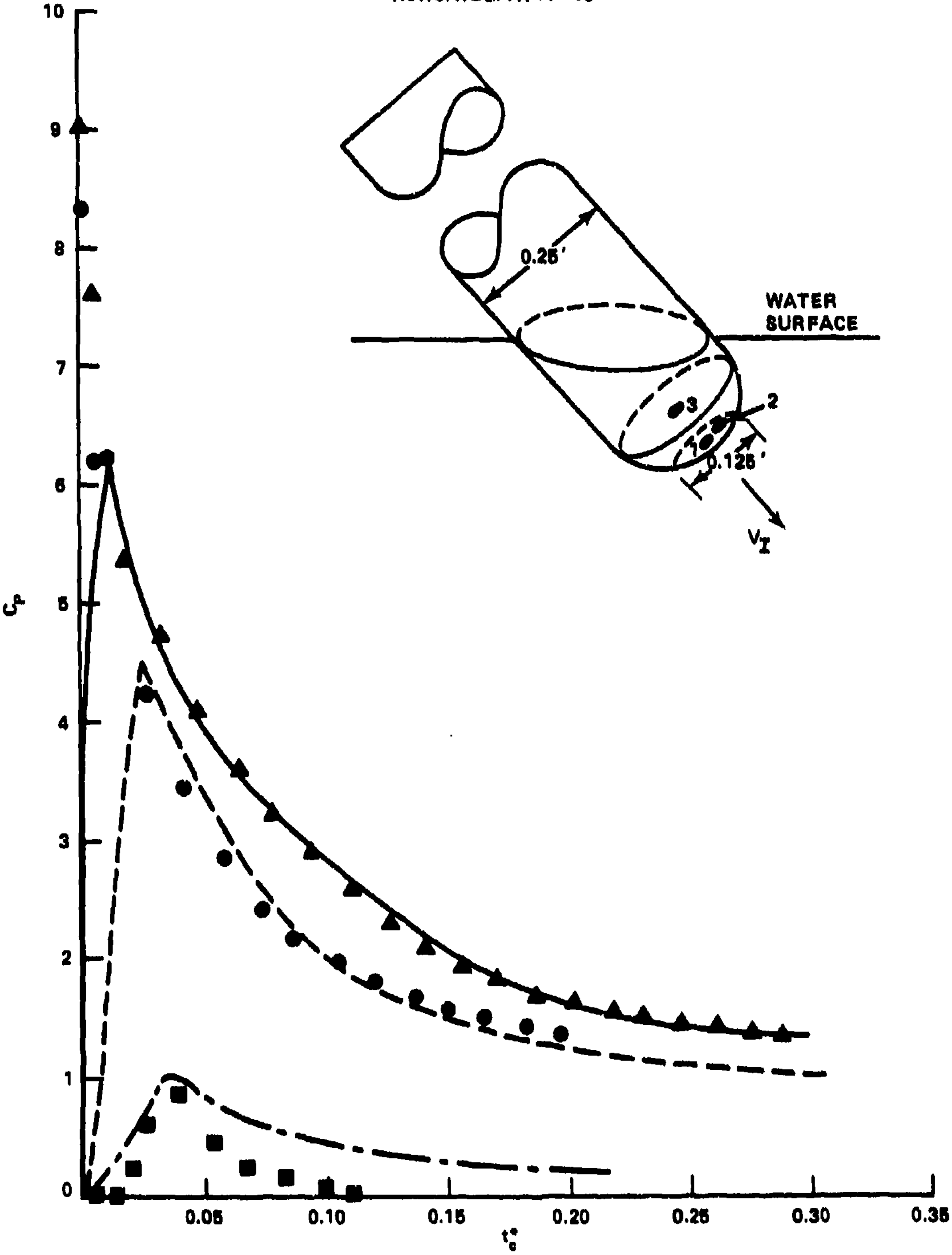

FIG. 32 CALCULATED AND MEASURED PRESSURE-TIME HISTORIES AT THREE DIFFERENT POSITIONS ON THE SURFACE OF AN OGIVE CYLINDER, Θ60 AND V_I = 100 FT/SEC. —— MEASURED AT POSITION 1 (r = 0) ▲ CALCULATED AT POSITION 1. – – – MEASURED AT POSITION 2 (r = 0.048', β = 90°) ● CALCULATED AT POSITION 2. — · — MEASURED AT POSITION 3 (r = 0.112', β = 90°) ■ CALCULATED AT POSITION 3. DATA ARE BY ARONSON

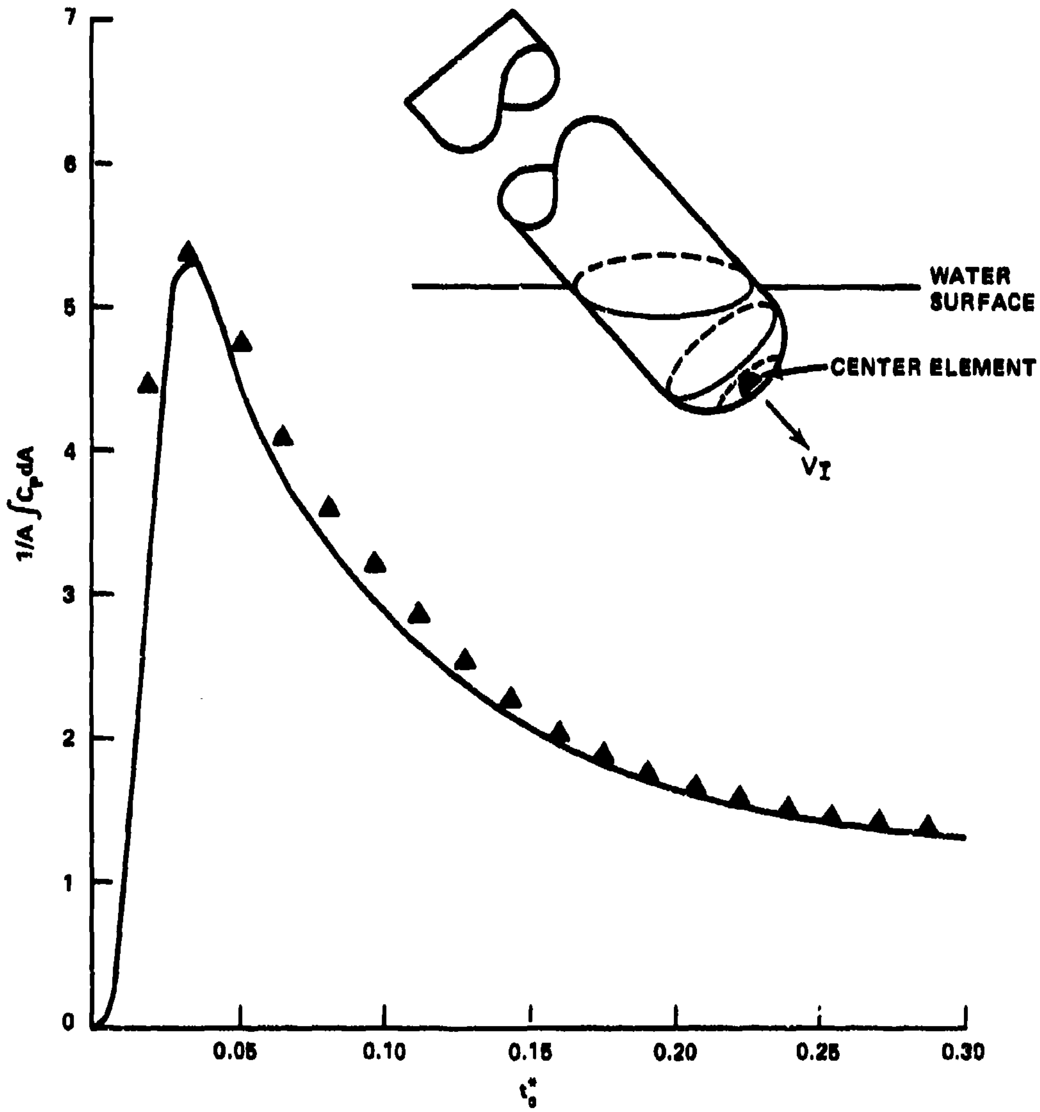

FIG. 33 CALCULATED AND EXPERIMENTAL LOAD ON THE CENTER ELEMENT OF THE OGIVE CYLINDER MODEL. ▲ CALCULATED. —— EXPERIMENTAL.

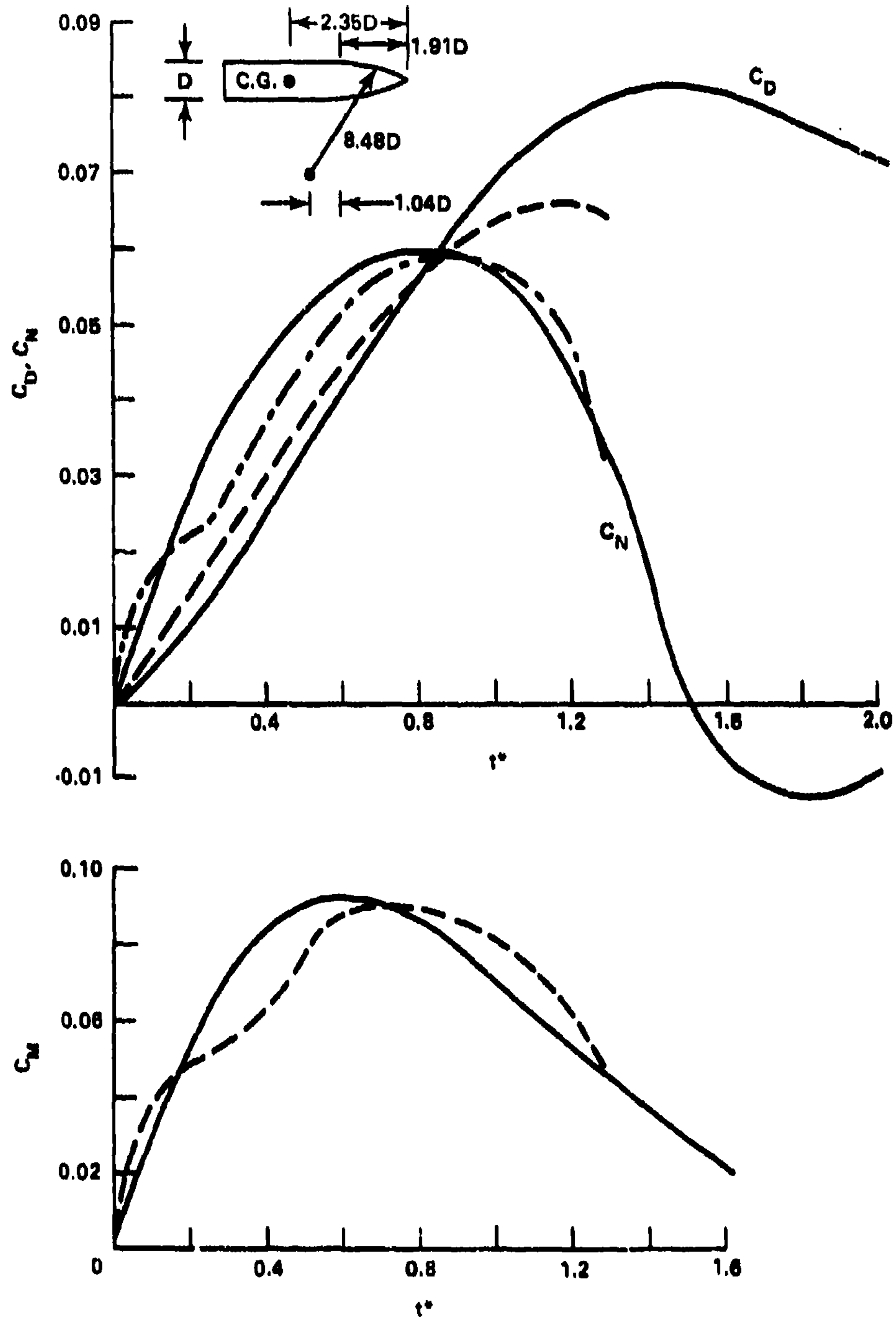

FIG. 34 MEASURED AND CALCULATED DRAG, PITCHING MOMENT AND NORMAL FORCE ON A SLENDER OGIVE ENTERING AT θ = 45° AND V_I=100 FT/SEC. SOLID CURVES ARE DATA BY BALDWIN. DOTTED AND DASHED CURVES ARE CALCULATED RESULTS.

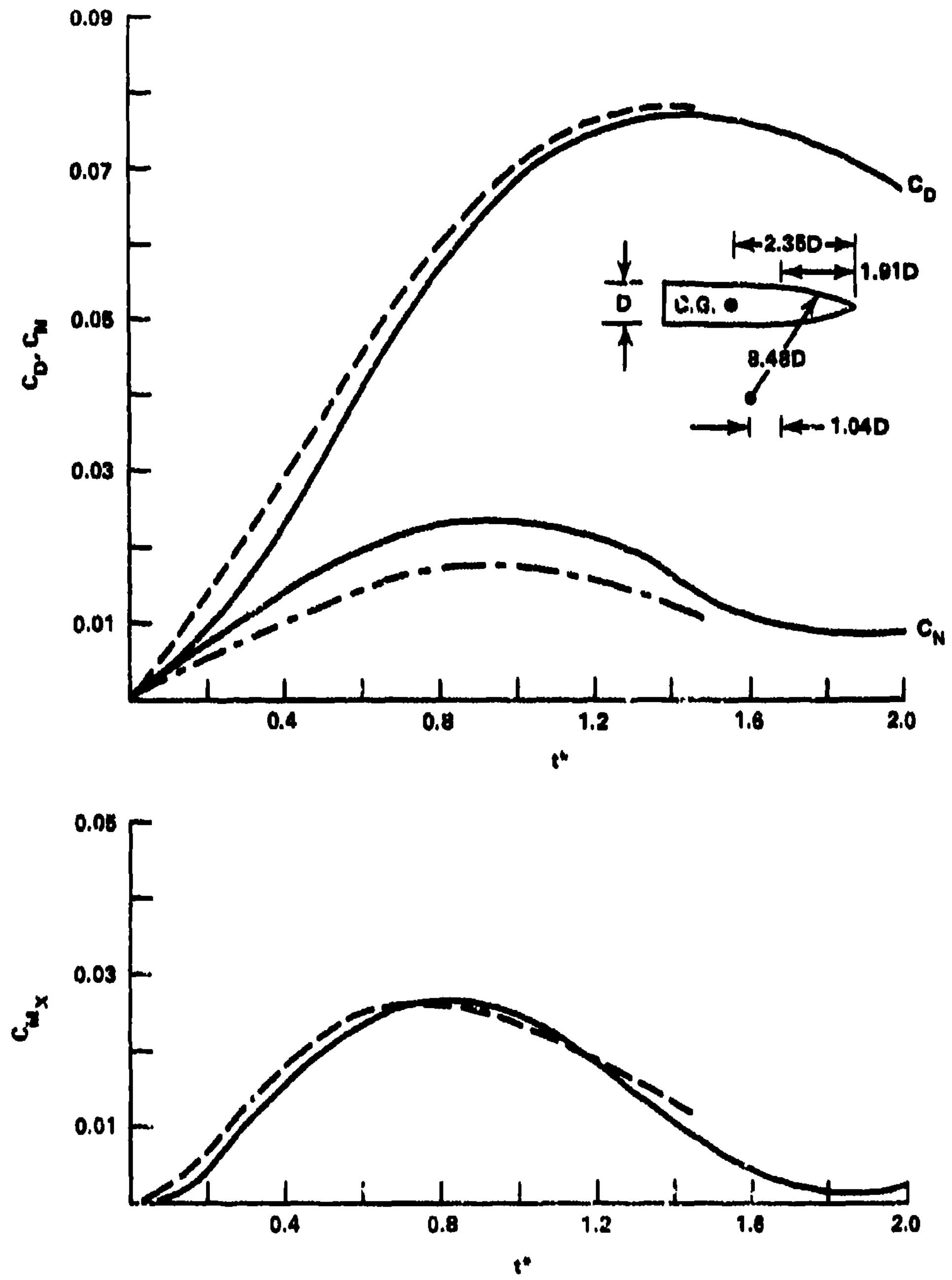

FIG. 35 MEASURED AND CALCULATED DRAG, PITCHING MOMENT AND NORMAL FORCE ON A SLENDER OGIVE ENTERING AT $\theta = 75°$ AND V ~ 100 FT/SEC. SOLID CURVES ARE DATA BY BALDWIN. DOTTED AND DASHED CURVES ARE CALCULATED RESULTS.

APPENDIX A

FORMULAS FOR THE INFLUENCE OF PLANAR, QUADRILATERAL ELEMENTS

This section lists formulas for calculating the influence of planar elements on arbitrary points in space, x,y,z. These expressions are taken from reference (11) and are listed here for the sake of completeness. The symbols to be used are defined in Figure A-1. Calculations are carried out using the element coordinate system and hence the velocity components are referenced to these axis:

$$V_\xi = -S_{12}Q_{12} - S_{23}Q_{23} - S_{34}Q_{34} - S_{41}Q_{41}$$

$$V_\eta = C_{12}Q_{12} + C_{23}Q_{23} + C_{34}Q_{34} + C_{41}Q_{41}$$

$$V_\gamma = \text{sign}(z)[\Delta\theta - J_{12} - J_{23} - J_{34} - J_{41}]$$

$$\phi = \phi_{12} + \phi_{23} + \phi_{34} + \phi_{41} - |z|\Delta\theta$$

where:

$\Delta\phi = 0$ unless $R_{12}, R_{23}, R_{34}, R_{41} > 0$ Then $\Delta\phi$ is 2π

$$\phi_{ij} = R_{ij}Q_{ij} + |z|J_{ij}$$

$$R_{ij} = (x - \xi_i)S_{ij} - (y - \eta_i)C_{ij}$$

$$Q_{ij} = \ln\left[\frac{r_i + r_j + d_{ij}}{r_i + r_j - d_{ij}}\right]$$

$$J_{ij} = \text{sgn}(Rij)[\tan^{-1}(|\frac{z}{R_{ij}}|\frac{S^j_{ij}}{r_j}) - \tan^{-1}(|\frac{z}{R_{ij}}|\frac{S^i_{ij}}{r_i})]$$

$$r_i = [(x - \xi_i)^2 + (y - \eta_i)^2 + z^2]^{1/2}$$

$$S^k_{ij} = (\xi_k - x)C_{ij} + (\eta_k - y)S_{ij}$$

$$C_{ij} = \frac{\xi_j - \xi_i}{d_{ij}}$$

$$S_{ij} = \frac{\eta_j - \eta_i}{d_{ij}}$$

$$d_{ij} = [(\xi_j - \xi_i)^2 + (\eta_j - \eta_i)^2]^{1/2}$$

At large distances from the element ($r_o/t > 4$), the element may be treated as a point source.. This greatly simplifies calculation of the velocity and potential:

$$\phi = \frac{I}{r_o} \qquad V_z = z\frac{I}{r_o^3}$$

$$V_\xi = \frac{x}{r_o^3} I \qquad I = \frac{1}{2}(\xi_3 - \xi_1)(\eta_2 - \eta_4)$$

$$V_\eta = \frac{y}{r_o^3} I$$

The equations for ϕ and $\overline{V}$ can be evaluated in any coordinate system. The final velocity components will be referenced to whatever system is used. At intermediate distances from the element, $2.45 < r_o/t < 4$, multipole expansions are used to evaluate the influence coefficients.

$$\phi = I_{00}w + \frac{1}{2}(I_{20}w_{xx} + 2I_{11}w_{xy} + I_{02}w_{yy})$$

$$V_\xi = -\frac{\partial\phi}{\partial x} = -I_{00}w_x - \frac{1}{2}(I_{20}w_{xxx} + 2I_{11}w_{xxy} + I_{02}w_{xyy})$$

$$V_\eta = -\frac{\partial\phi}{\partial y} = -I_{00}w_y - \frac{1}{2}(I_{20}w_{xxy} + 2I_{11}w_{xyy} + I_{02}w_{yyy})$$

$$V_\gamma = -\frac{\partial\phi}{\partial z} = -I_{00}w_z - \frac{1}{2}(I_{20}w_{xxz} + 2I_{11}w_{xyz} + I_{02}w_{yyz})$$

where:

$$w = r_o^{-1} \qquad w_{xxx} = 3x(3p + 10x^2)r_o^{-7}$$

$$w_x = -xr_o^{-3} \qquad w_{xxy} = 3ypr_o^{-7}$$

$$w_y = -yr_o^{-3} \qquad w_{xyy} = 3xqr_o^{-7}$$

$$w_z = -zr_o^{-3} \qquad w_{yyy} = 3y(3q + 10y^2)r_o^{-7}$$

$$w_{xx} = -(p + 2x^2)r_o^{-5} \qquad w_{xxz} = 3zpr_o^{-7}$$

$$w_{xy} = 3xyr_o^{-5} \qquad w_{xyz} = -15xyzr_o^{-7}$$

$$w_{yy} = -(q + 2y^2)r_o^{-5} \qquad w_{yyz} = 3zqr_o^{-7}$$

$$p = y^2 + z^2 - 4x^2 \qquad q = x^2 + z^2 - 4y^2.$$

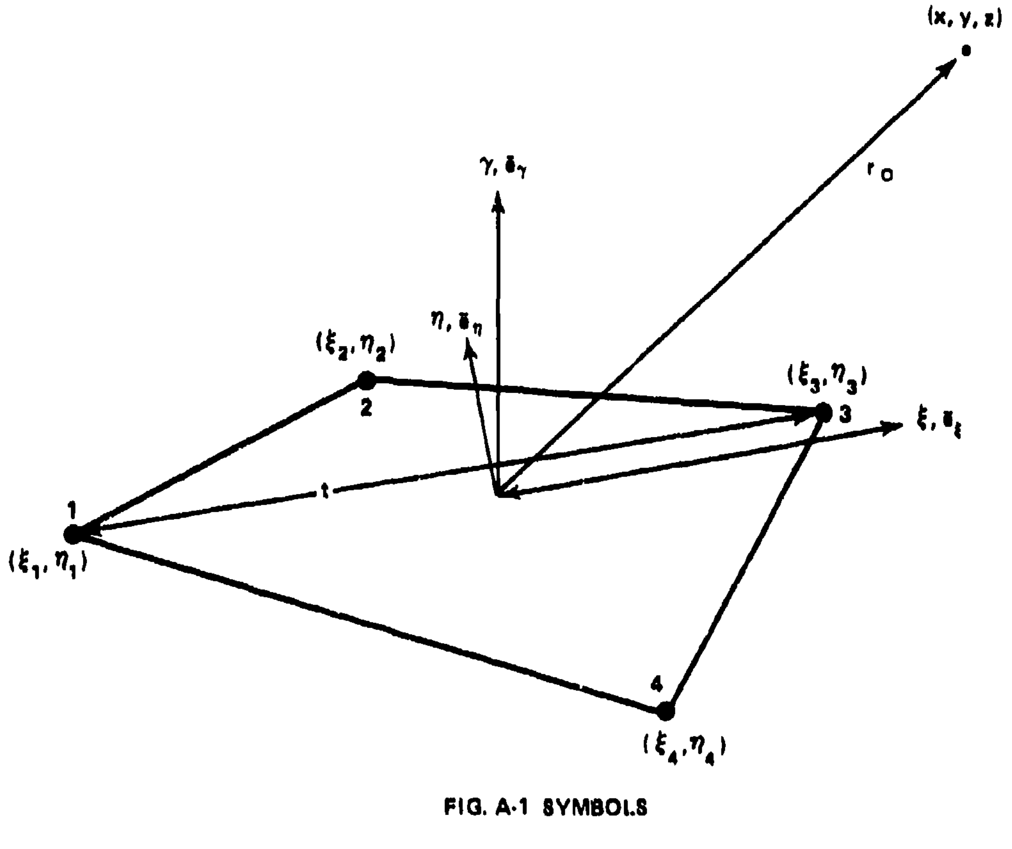

FIG. A-1 COORDINATE SYSTEM

APPENDIX B

DESCRIPTION OF THE COMPUTER PROGRAM

The computer program consists of the main routine, ENTRY, eighteen subroutines and one function. The flow chart for the program is given in Table B-1 and the main program variables are listed in Table B-2. A program listing is provided in Table B-3.

Program execution is initiated in ENTRY by calling subroutine INDATA which reads the required input (see Appendix C for a description of input cards). Based on options specified by the user a grid is set up on the surface of the model using subroutines STANG, LISTG, and OGIVG. Node points describing the surface of the body are stored in body (x', y', z') and water surface coordinates (x, y, z) in arrays X and XT respectively. The identification numbers of the four nodes defining the Jth element are stored in array IN(1, J), IN(2, J), IN(3, J) and IN(4, J). The coordinates of each node point, nodes making up each element and element centroids are printed in subroutine ELEMST. This terminates the element definition portion of the program which is executed only once.

The following sequence is executed at each step. The center of gravity of the entry body is inserted the prescribed increment in depth and the corresponding position of each node point is calculated by subroutine ADVN. Subroutine CREL is called which examines all elements to determine which are submerged. Elements split by the water surface are redefined using new node points which located on the water surface and stored at the ends of arrays X and XT. The nodes making up submerged elements are stored sequentially in array IT. The original reference number of each submerged element is stored in array IQ and the code indicating its state (i.e., modified, unmodified or split) in array IM. Upon completion of subroutine CREL, MAN is called which calculates the area, centroid and unit vectors of each element. If the PRINT option is used, element information is printed out by ELEMST for elements which are modified or unmodified for the first time. This information includes centroid and node locations in both coordinate systems, element areas and unit vector components. The arrays X, XT, IN, XC, XCP, VNO, E, IT, PHIO, IQ, IM are written on TAPE 15 by ENTRY. The coefficients of matrices A, B, C, and D are calculated by subroutine AMAT using the equations of Appendix A and written on TAPE 16. To determine the induced velocity normal to each element centroid (i.e., the right hand side of equation (13)) subroutine VNORM is called. The source strengths of equation (13) are calculated using DDECOMP and DSOLVE. These subroutines are called from SUAS which sets up matrix A in appropriate blocks using information on Tape 16. The element information stored on TAPE 15 and the matrices B, C, and D stored on TAPE 16 are recalled to allow velocity and potential values to be calculated at each centroid element in subroutine OUTPUT using equation (14). If the PRINT option is used, this information is also printed. Data necessary for calculating pressures and loads are stored on TAPE 17.

The above procedure is repeated until termination occurs. This can be triggered by reaching a step number greater than IMAX, having the number of submerged elements exceed NDIM, or having the computational time approach the job time limit. This last option is necessary since pressures and loads, of principal concern, are calculated at the end of the program. To insure that these quantities are computed the code estimates the amount of time required to complete each step before starting it. If the total estimated time estimated exceeds 90 percent of the job time limit, the flow field calculation is terminated and the program branches to subroutine PRESF which calculates pressures and loads using the equations (18) through (21).

TABLE B-1
PROGRAM FLOW CHART

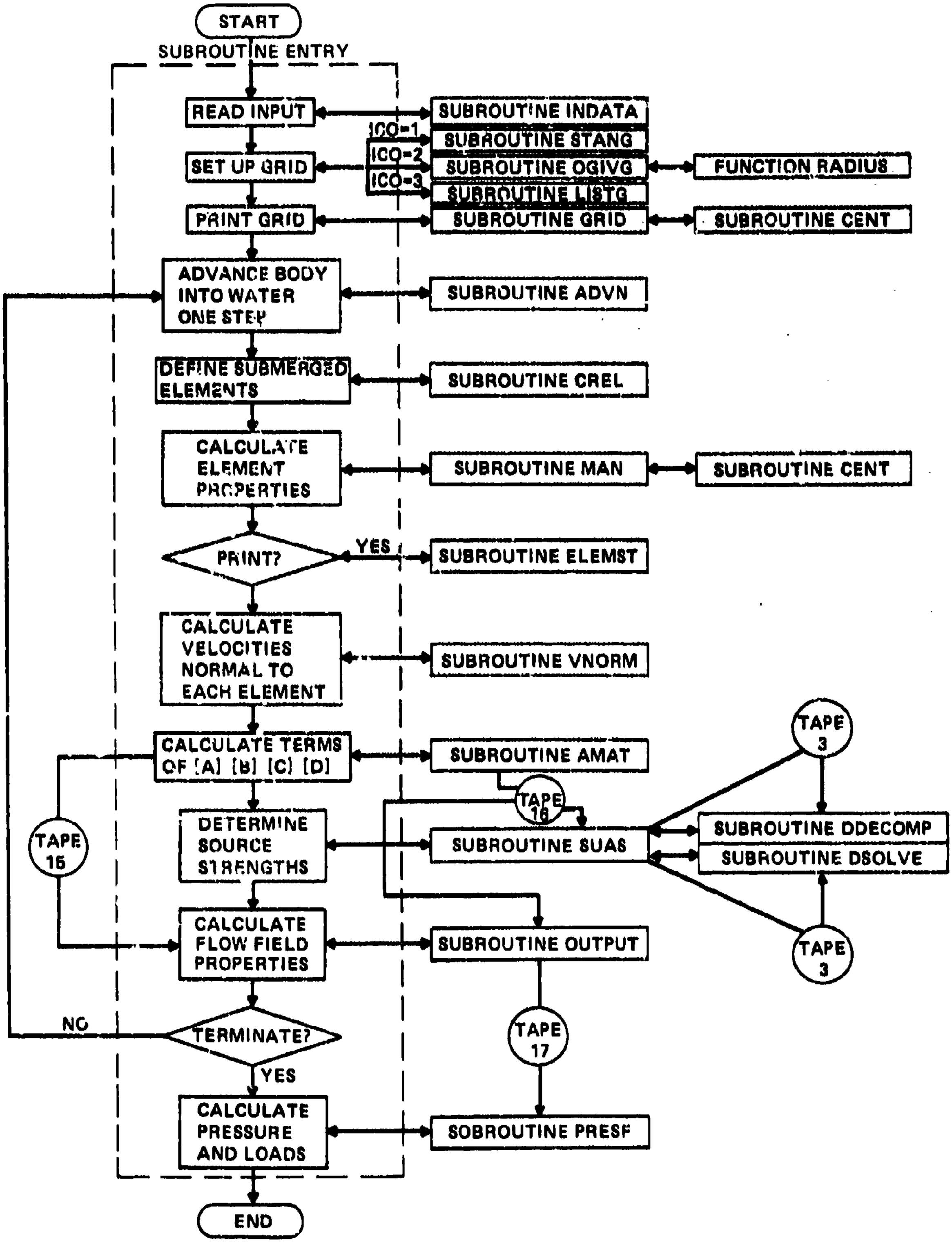

TABLE B-2

MAIN VARIABLES

VARIABLE	TYPE	DEFINITION
AN,AX,AY,ANS, AXS,AYS	ARRAY	TEMPORARY STORAGE IN AMAT AND OUTPUT
CGL	SIMPLE	z' COORDINATE OF CENTER OF GRAVITY
CW	ARRAY	WETTING FACTORS USE DURING CONSTANT ORIENTATION ENTRY
CWT(I)	ARRAY	WETTING FACTOR BETWEEN STEPS I-1 AND I
D	SIMPLE	MODEL DIAMETER. USED ONLY IN CALCULATING DIMENSIONLESS QUANTITIES
DT(I)	ARRAY	INCREMENT IN TIME BETWEEN STEPS I-1 AND I
E(I,J,K)	ARRAY	ELEMENT UNIT VECTORS. I = 1,2,3 ARE COMPONENTS ALONG x,y,z AXIS. J = 1,2,3 ARE UNIT VECTORS ξ, η, AND γ RESPECTIVELY. K IS ELEMENT NUMBER
HMIN	SIMPLE	INITIAL MODEL DEPTH
HMAX	SIMPLE	INCREASE IN MODEL DEPTH DUE TO RISING MOTION OF SURFACE
ICON	SIMPLE	IF ICON = 0, CONSTANT ORIENTATION ENTRY IS ASSUMED. IF ICON = 1 VARIABLE ORIENTATION IS USED
IEM	SIMPLE	NUMBER OF SUBMERGED ELEMENTS
IM(I)	ARRAY	I IS ELEMENT NUMBER, IM = 0, IM = 1, AND IM = 2, INDICATE NOT MODIFIED, MODIFIED AND SPLIT ELEMENTS RESPECTIVELY
IN(I,J)	ARRAY	NODES DEFINING CORNER LOCATIONS. I IS THE CORNER NUMBER AND J IS THE ELEMENT NUMBER
INP	SIMPLE	TOTAL NUMBER OF DEFINED NODES. INCLUDES NODES GENERATED TO DESCRIBE MODIFIED ELEMENTS
IP	ARRAY	USED IN DDECOMP AND DSOLVE

TABLE B-2 (Continued)

VARIABLE	TYPE	DEFINITION
IPRINT	SIMPLE	IF IPRINT = 1 PRINT OPTION IS EXERCISED
IPHI	SIMPLE	IF IPHI = 1 PLANAR SYMMETRY IS ASSUMED
IQ(K)	ARRAY	ORIGINAL IDENTIFICATION NUMBER OF SUBMERGED ELEMENTS. K IS THE IDENTIFICATION NUMBER OF THE SUBMERGED ELEMENT
IT(I,K)	ARRAY	IDENTIFICATION NUMBER OF NODES DESCRIBING THE Kth SUBMERGED ELEMENT
NCW	SIMPLE	NUMBER OF WETTING FACTORS TO BE USED DURING CONSTANT ORIENTATION ENTRY
NDIM	SIMPLE	MAXIMUM ALLOWABLE NUMBER OF SUBMERGED ELEMENTS
NEL	SIMPLE	NUMBER OF ELEMENTS INITIALLY DEFINED
PHI	ARRAY	TEMPORARY STORAGE IN AMAT
PHIS	ARRAY	TEMPORARY STORAGE IN OUTPUT
SIG(K)	ARRAY	SOURCE STRENGTH OF ELEMENT K
STOR	ARRAY	TEMPORARY STORAGE IN SUAS
SUMT	SIMPLE	90 PERCENT OF TIME LIMIT
VENTRY	SIMPLE	ENTRY VELOCITY
VEX(I),VEY(I), VEZ(I)	ARRAY	VELOCITY COMPONENTS IN THE x,y, AND z DIRECTION USED BETWEEN STEPS I and I-1
VNO(I)	ARRAY	VELOCITY NORMAL TO ELEMENT I
WX(I)	ARRAY	ANGULAR VELOCITY IN THE PITCH PLANE BETWEEN STEPS I AND I-1
X(I,K)	ARRAY	COORDINATES OF THE Kth NODE. I = 1,2,3 REFER TO THE x',y',z' AXES RESPECTIVELY
XC(I,K)	ARRAY	COORDINATES OF THE CENTROID OF THE Kth ELEMENT. I = 1,2,3 REFER TO THE x',y', AND z' AXES RESPECTIVELY

TABLE B-2 (Continued)

VARIABLE	TYPE	DEFINITION
XCP(I,K)	ARRAY	COORDINATES OF THE CENTROID OF THE Kth ELEMENT. I = 1,2,3 REFER TO THE x,y, AND z AXIS RESPECTIVELY
XCPB(I)	ARRAY	COORDINATES OF THE CENTER OF GRAVITY. I = 1,2,3 REFER TO THE x,y,z AXES RESPECTIVELY
XT(I,K)	ARRAY	COORDINATES OF THE Kth NODE. I = 1,2,3 REFER TO THE x,y,z AXES

```
      PROGRAM ENTRY(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE15=512,   ENTRY     2
     *TAPE16=512,TAPE17=512,TAPE3)                                      DEC02     1
      COMMON A(120,120),SIG(300),IP(300)                                JAN01     1
      DIMENSION X(3,1),XT(3,1),XC(3,1),XCP(3,1),VNO(1),PHIO(2,1),       ENTRY     5
     *E(3,3,1),IN(4,1),IT(4,1),IO(1),IM(1),AN(1),AX(1),                 ENTRY     6
     *AY(1),PHI(1),ANS(1),AXS(1),AYS(1),PHIS(1),CW(20),                 ENTRY     7
     *VEZ(50),VEY(50),VEX(50),WX(50),DT(50),XCPR(3),CWT(50)             NOV03     1
     *,IGRID(1),STOR(1),INDEX(20)                                       DEC06     1
C.....EQUIVALENCE STATEMENTS                                            DEC01     3
C.....THE A ARRAY IS SET UP TO HANDLE 300 SUBMERGED ELEMENTS.           DEC01     4
C.....SPECIFIED GRID MAY BE AS LARGE AS 500 ELEMENTS AND 800 NODES.     DEC01     5
C.....EXECUTION WILL TERMINATE WHEN MORE THAN THREE HUNDRED OF THESE    DEC01     6
C.....ELEMENTS ARE SUBMERGED.                                           DEC01     7
C.....MASS STORAGE IS SET UP FOR A MAXIMUM OF 19 DATA BLOCKS.           DEC01     8
C.....NDIM=MAXIMUM NUMBER OF SUBMERGED ELEMENTS.                        DEC01     9
C.....MNPT=MAXIMUM NUMBER OF NODES                                      DEC01    10
C.....MNEL=MAXIMUM NUMBER OF ELEMENTS.                                  DEC01    11
C.....NBLK=DIMENSION OF A ARRAY                                         JAN01     2
C.....PRIMARY A ARRAY STORAGE                                           DEC01    12
C.....          A(1),X(1)                                               DEC01    13
C.....          A(3*MNPT+1),XT(1)                                       DEC01    14
C.....          A(6*MNPT+1),IN(1)                                       DEC01    15
C.....          A(6*MNPT+4*MNEL+1),XC(1)                                DEC01    16
C.....          A(6*MNPT+4*MNEL+3*NDIM+1),XCP(1)                        DEC01    17
C.....          A(6*MNPT+4*MNEL+6*NDIM+1),VNO(1)                        DEC01    18
C.....          A(6*MNPT+4*MNEL+7*NDIM+1),E(1)                          DEC01    19
C.....          A(6*MNPT+4*MNEL+16*NDIM+1),IT(1)                        DEC01    20
C.....          A(6*MNPT+4*MNEL+20*NDIM+1),PHIO(1)                      DEC01    21
C.....          A(6*MNPT+6*MNEL+20*NDIM+1),IO(1)                        DEC01    22
C.....          A(6*MNPT+6*MNEL+21*NDIM+1),STOR(1)                      DEC01    23
C.....MAXIMUM STORAGE REQUIREMENT FOR A IS 6*MNPT+6*MNEL+22*NDIM.       DEC01    24
C.....SECONDARY STORAGE FOR A ARRAY                                     DEC01    25
C.....          A(1),AN(1)                                              DEC01    26
C.....          A(NDIM+1),AX(1)                                         DEC01    27
C.....          A(2*NDIM+1),AY(1)                                       DEC01    28
C.....          A(3*NDIM+1),PHI(1)                                      DEC01    29
C.....          A(4*NDIM+1),ANS(1)                                      DEC01    30
C.....          A(6*NDIM+1),AXS(1)                                      DEC01    31
C.....          A(6*NDIM+1),AYS(1)                                      DEC01    32
C.....          A(7*NDIM+1),PHIS(1)                                     DEC01    33
C.....TOTAL STORAGE REQUIREMENTS ARE 8*NDIM                             DEC01    34
      EQUIVALENCE (A(1),X(1)),(A(2401),XT(1)),(A(4801),IN(1)),          DEC01    35
     *(A(6801),XC(1)),(A(7701),XCP(1)),(A(8601),VNO(1)),(A(8901),E(1)), DEC01    36
     *(A(11601),IT(1)),(A(12801),PHIO(1)),(A(13801),IO(1)),             DEC27     1
     *(A(14101),STOR(1))                                                DEC01    38
      EQUIVALENCE (A(1),AN(1)),(A(301),AX(1)),(A(601),AY(1)),           DEC01    39
     *(A(901),PHI(1)),(A(1201),ANS(1)),(A(1501),AXS(1)),(A(1801),AYS(1)) DEC01   40
     *,(A(2101),PHIS(1))                                                DEC01    41
      EQUIVALENCE(IP(1),IM(1))                                          ENTRY    25
C.....STORAGE CONSTANTS                                                 DEC01    42
      NDIM=300                                                          DEC01    43
      NPT=NEL=0                                                         DEC03     1
      ZTC=YTC=0.0                                                       DEC03     2
      NBLK=120                                                          JAN01     3
      IAVS=NBLK*NBLK/2                                                  JAN01     4
      CALL OPENMS(3,INDEX,19,0)                                         DEC03     3
C.....READ IN OPTIONS                                                   ENTRY    39
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PHOGRAM ENTRY      73/73   OPT=1                          FTN 4.5+410       77/01/17. 11.07.10        PAGE    2

      CALL INDATA(IPRINT,IPHI,INODE,IGRID,IMAX,HMIN,ICON,SUMT,            ENTRY     40
     *SUMF,D,DT,CWT,CW,VEZ,VEY,VEX,WX,ANG,XCPB,CGL,VENTRY,NCW,NMLD,FCF)   DEC27      4
C.....SET UP GRID                                                         ENTRY     42
      NN=IGRID(1)+1                                                       DEC06      2
      DO 4 II=2,NN                                                        DEC06      3
      ICO=IGRID(II)                                                       DEC06      4
      IF(ICO.EQ.1)CALL STANG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)       DEC06      5
      IF(ICO.EQ.2)CALL OGIVG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)       DEC06      6
      IF(ICO.EQ.3)CALL LISTG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)       JAN10      2
    4 CONTINUE                                                            DEC06      9
      CALL GRID(NPT,NEL,X,XT,IN,PHIO,XC,ACHECK,NMLD)                      DEC14      3
C.....SET MISCELLANEOUS CONSTANTS                                         ENTRY     48
      ISTEP=0                                                             NOV03      5
      CPC=0.0                                                             ENTRY     49
      SUM=SECOND(AQ)                                                      ENTRY     50
      DO 15 J=1,2                                                         ENTRY     51
      DO 15 I=1,NEL                                                       ENTRY     52
   15 PHIO(J,I)=0.0                                                       ENTRY     53
C.....MAIN LOOP                                                           ENTRY     54
   20 ISTEP=ISTEP+1                                                       ENTRY     55
      IF(ISTEP.NE.1)READ(15)A                                             ENTRY     56
      REWIND 15                                                           ENTRY     57
C.....ADVANCE ALL NODES                                                   ENTRY     58
      CALL ADVN(XT,VEZ,VEY,VEX,CWT,WX,ANG,XCPB,ISTEP,NPT,DT,DDZ,          NOV03      6
     *HMAX)                                                               NOV03      7
C.....DETERMINE WHICH ELEMENTS ARE VALID                                  ENTRY     60
      CALL CREL(X,IN,IT,IQ,IM,IEM,NPT,NEL,ANG,INP,XT,XCPB,CGL,ACHECK)     NOV15      2
      IF(IEM.GT.NDIM)GO TO 21                                             ENTRY     62
C.....CALCULATE ELEMENT VECTORS,CENTROIDS AND TRANSFORM NODES FROM        ENTRY     63
C.....BODY TO WATER COORDINATES                                           ENTRY     64
      CALL MAN(X,IT,XT,XC,XCP,IEM,ANG,PHIO,IQ,XCPB,CGL,E)                 NOV05      1
      XIEM2=IEM*IEM                                                       ENTRY     66
      IF(CPC*XIEM2+SUM+SUMF.GT.SUMT)GO TO 21                              ENTRY     67
      IF(IPRINT.EQ.1.AND.NPT.NE.INP)CALL ELEMST(INP,NPT,IT,IEM,IQ,IM,     JAN10      3
     1X,XT,XC,XCP,E,PHIO,ISTEP,HMAX)                                      JAN10      4
      CALL VNORM(VEZ,VEY,VEX,WX,VNO,E,IEM,ISTEP,XCP,XCPB,IPRINT)          NOV08      2
      WRITE(15)A,IP                                                       ENTRY     70
      REWIND 15                                                           ENTRY     71
C.....CALCULATE MATRICES                                                  ENTRY     72
      CALL AMAT(XCP,XT,IT,IEM,AN,AY,AX,PHI,VNO,F,IPHI)                    NOV09      1
C.....INVERT MATIX AND DETERMINE SOURCE STRENGTHS                         ENTRY     74
      CALL SUAS(IEM,IAVS,NBLK,A,IP,VNO,SIG,STOR)                          JAN01      5
C.....CALCULATE FLOW QUANTITIES                                           ENTRY     90
      READ(15)A,IP                                                        ENTRY     91
      REWIND 15                                                           ENTRY     92
      CALL OUTPUT(IEM,IT,IN,ANG,SIG,VNO,AN,ANS,AX,AXS,AY,AYS,PHI,PHIS,    NOV03     10
     *PHIO,XC,XCP,IQ,IM,E,IPRINT,DDZ,HMAX,XCPB)                           NOV03     11
C.....TERMINATE CHECK                                                     ENTRY     95
      SUMP=SUM                                                            ENTRY     96
      SUM=SECOND(AQ)                                                      ENTRY     97
      SUMD=SUM-SUMP                                                       ENTRY     98
      CPC=SUMD/XIEM2                                                      ENTRY     99
      IF(IPRINT.EQ.1)WRITE(6,2031)SUMD                                    ENTRY    100
      IF(IPRINT.EQ.0)WRITE(6,2032)ISTEP,SUMD                              ENTRY    101
 2032 FORMAT(1H9,5HSTEP ,I5,30H COMPLETE.CP TIME FOR STEP IS ,F10.5)      ENTRY    102
 2031 FORMAT(1H0,20X,18HCP TIME FOR CYCLE ,F10.5)                         ENTRY    103
      IF(SUMT-SUM.LT.SUMF)GO TO 22                                        ENTRY    104
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PROGRAM ENTRY       73/73    OPT=1                         FTN 4.5+410        77/01/17. 11.07.10        PAGE     3

                IF(ISTEP.LE.IMAX)GO TO 20                                      NOV03      12
             22 ISTEP=ISTEP+1                                                  ENTRY     106
             21 CONTINUE                                                       ENTRY     107
                REWIND 17                                                      ENTRY     108
          C.....CALCULATE PRESSURE AND FORCES                                  ENTRY     109
                CALL PRESF(ISTEP,IMODE,WX,VEZ,VEY,VEX,HMIN,CW,DT,ICON,CWT,     ENTRY     110
               *CGL,NCW,D,WENTRY,IPHI,NNLD,FCF)                                JAN10       5
                STOP                                                           ENTRY     112
                END                                                            ENTRY     113
```

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SUBROUTINE INDATA     73/73   OPT=1                        FTN 4.5+410        77/01/17. 11.07.10        PAGE    1

        SUBROUTINE INDATA(IPRINT,IPHI,IMODE,IGRID,IMAX,HMIN,ICON,SUMT,           INDATA     2
       *SUMF,D,DT,CWT,CW,VEZ,VEY,VEX,WX,ANG,XCPB,CGL,VENTRY,NCW,NNLD,FCF)        DEC27      7
        DIMENSION DT(1),CWT(1),CW(1),VEZ(1),VEY(1),VEX(1),WX(1),XCPB(1)          NOV03     14
       *,IGRID(1)                                                                DEC06     10
C.....READ IN OPTIONS                                                             INDATA     5
        EPS=1.-06                                                                JAN10      6
        CONVR=57.29577951                                                        DEC06     11
        NCW=1                                                                    INDATA     6
        IMODE=0                                                                  DEC06     12
        READ(5,1000)CON1,CON2                                                    DEC06     13
        ICON=1                                                                   DEC06     14
        IF(CON1.EQ.4HCONS)ICON=0                                                 DEC06     15
        WRITE(6,1999)CON1,CON2                                                   DEC06     16
 1999   FORMAT(1H1,36X,29H*******PROGRAM OPTIONS*******/1H,36X,2A4,* BODY        DEC06     17
       *ORIENTATION*)                                                            DEC06     18
        READ(5,1000)CON1,CON2,CON3                                               DEC06     19
        IPRINT=0                                                                 INDATA     8
        IF(CON1.EQ.4HPRIN)IPRINT=1                                               DEC06     20
        WRITE(6,1998)CON1,CON2,CON3                                              DEC06     21
 1998   FORMAT(1H ,36X,3A4)                                                      DEC06     22
        READ(5,1000)CON1,CON2,CON3                                               DEC06     23
        IPHI=1                                                                   INDATA    13
        IF(CON1.EQ.4HASYM)IPHI=2                                                 DEC06     24
        WRITE(6,1997)CON1,CON2,CON3                                              DEC06     25
 1997   FORMAT(1H ,36X,2A4,A2,* CONFIGURATION*)                                  DEC06     26
C.....READ IN CONTROL PARAMETERS                                                  INDATA    26
        READ(5,1003)IMAX,D,VENTRY,ANG,SUMT,HMIN,DH,ALPHA                         DEC06     27
        READ(5,1004)CGL,FCF,ANGBB,NNLD                                           DEC27      8
        IF(NNLD.EQ.0)NNLD=10000                                                  DEC14      8
        WRITE(6,2000)                                                            INDATA    29
 2000   FORMAT(1H0,34X,32H*******PROBLEM PARAMETERS*******)                      NOV02      3
        WRITE(6,2001)D                                                           INDATA    31
 2001   FORMAT(1H ,40X,9HDIAMETER ,F6.4,3H FT)                                   INDATA    32
        WRITE(6,2021)VENTRY                                                      INDATA    33
 2021   FORMAT(1H ,46X,15HENTRY VELOCITY ,F10.3,8H(FT/SEC))                      INDATA    34
        WRITE(6,2004)ANG                                                         INDATA    35
 2004   FORMAT(1H ,40X,*BODY ORIENTATION ANGLE *,F6.2,8H DEGREES)                INDATA    36
        WRITE(6,2005)HMIN,IMAX                                                   INDATA    38
 2005   FORMAT(1H ,30X,13HINITIAL DEPTH ,F .5,3H FT,*   TERMINATION STEP*        NOV03     17
       *,I3                                                                      NOV03     18
        IF(FCF.LT.1.E-02)FCF=1.                                                  DEC27      9
        IF(HMIN.GT.1.E-08)IMAX=IMAX+1                                            DEC27     10
        WRITE(6,2009)FCF                                                         DEC27     11
 2009   FORMAT(1H ,33X,*INITIAL PRESSURE CORRECTION FACTOR = *,F7.4)             DEC27     12
        SUMF=SUMT*.1                                                             NOV05      5
        XCPB(1)=XCPB(2)=0.0                                                      INDATA    42
        XCPB(3)=CGL                                                              INDATA    43
        WRITE(6,2008)XCPB(1),XCPB(2),XCPB(3)                                     INDATA    44
 2008   FORMAT(1H ,19X,*CENTROIDE COORDINATES *,3(2X,F10.5))                     INDATA    45
        IF(ICON.NE.0)GO TO 30                                                    DEC06     28
C.....CONSTANT VELOCITY                                                           DEC06     29
        WRITE(6,2002)DH                                                          DEC06     30
        WRITE(6,2003)ALPHA                                                       DEC06     31
        WRITE(6,2010)ANGBB                                                       DEC27     13
 2002   FORMAT(1H ,38X,*INCREMENT IN DEPTH *,F10.7)                              DEC06     32
 2003   FORMAT(1H ,45X,*ANGLE OF ATTACK *,F7.2)                                  DEC06     33
 2010   FORMAT(1H ,43X,*YAW ANGLE *,F7.2)                                        DEC27     14
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SUBROUTINE INDATA      73/73    OPT=1                    FTN 4.5+410        77/01/17. 11.07.10       PAGE     2

              READ(5,1002)NCW,(CW(I),I=1,NCW)                                      DEC06     34
              WRITE(6,2022)(CW(I),I=1,NCW)                                         DEC06     35
              NVP=1                                                                DEC06     36
              VEX(1)=SIN(ANGBB/CONVR)*VENTRY                                       DEC27     15
              VEY(1)=-COS(ANGBB/CONVR)*COS((ANG+ALPHA)/CONVR)*VENTRY               DEC27     16
              VEZ(1)=-COS(ANGBB/CONVR)*SIN((ANG+ALPHA)/CONVR)*VENTRY               DEC27     17
              WX(1)=0.0                                                            DEC06     40
              DT(1)=-DH/(VEZ(1)*CW(1))                                             DEC06     41
              CWT(1)=CW(1)                                                         DEC06     42
              GO TO 40                                                             DEC06     43
        C.....VARIABLE ENTRY VELOCITY                                              DEC06     44
         2022 FORMAT(1H0,40X,15HWETTING FACTORS/(43X,F10.5))                       INDATA    47
        C.....READ IN VELOCITY HISTORY                                             INDATA    48
           30 CONTINUE                                                             DEC06     45
              NCW=1                                                                DEC14      9
              READ(5,1002)NVP                                                      INDATA    49
              WRITE(6,2006)                                                        INDATA    50
              DO 10 I=1,NVP                                                        INDATA    51
              READ(5,1001)VEX(I),VEY(I),VEZ(I),WX(I),CWT(I),DT(I)                  NOV03     19
              WRITE(6,2007)I,VEX(I),VEY(I),VEZ(I),WX(I),CWT(I),DT(I)               NOV03     20
              DT(I)=-DT(I)/(CWT(I)*VEZ(I))                                         DEC15      1
           10 CONTINUE                                                             INDATA    54
         2007 FORMAT(1H ,25X,I5,3F10.4,F10.1,2F10.6)                               NOV08      3
         2006 FORMAT(1H0,27X,*NO*,7X,*VX*,8X,*VY*,8X,*VZ*,8X,*WX*,8X,*CWT*,8X,     INDATA    56
             1*H*)                                                                 DEC15      2
        C.....DEFINE CONDITIONS FOR EACH STEP                                      DEC06     46
           40 NVP1=NVP+1                                                           DEC06     47
              DO 20 I=NVP1,50                                                      INDATA    59
              VEX(I)=VEX(NVP)                                                      NOV03     21
              VEY(I)=VEY(NVP)                                                      NOV03     22
              VEZ(I)=VEZ(NVP)                                                      NOV03     23
              WX(I)=WX(NVP)                                                        INDATA    63
              CWT(I)=CWT(NVP)                                                      INDATA    64
           20 DT(I)=DT(NVP)                                                        INDATA    65
              DT(I)=DT(I)*(1.+EPS)                                                 JAN19      7
        C.....GRID OPTIONS                                                         DEC06     48
              READ(5,1002)N                                                        DEC06     49
              IGRID(1)=N                                                           DEC06     50
              WRITE(6,1996)                                                        DEC06     51
              DO 70 I=1,N                                                          DEC06     52
              I1=I+1                                                               DEC06     53
              IGRID(I1)=1                                                          DEC06     54
              READ(5,1000)GRID,GRID2,GRID3                                         DEC06     55
              IF(GRID.EQ.4HOGIV)IGRID(I1)=2                                        DEC06     56
              IF(GRID.EQ.4HLIST)IGRID(I1)=3                                        JAN10      8
              WRITE(6,1995)GRID,GRID2,GRID3                                        DEC06     59
           70 CONTINUE                                                             DEC06     60
         1995 FORMAT(1H ,40X,3A4)                                                  DEC06     61
         1996 FORMAT(1H0,34X,26H*******GRID OPTIONS*******)                        DEC06     62
         1000 FORMAT(12A4)                                                         DEC06     63
         1001 FORMAT(8F10.0)                                                       INDATA    68
         1002 FORMAT(I5,5X,7F10.0/(8F10.0))                                        INDATA    69
         1003 FORMAT(I5,5X,7F10.0)                                                 DEC06     64
         1004 FORMAT(3F10.0,I5)                                                    DEC27     18
              END                                                                  INDATA    70
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      SUBROUTINE INDATA     73/73   OPT=1                  FTN 4.5+410      77/01/17. 11.07.10      PAGE    3

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

     46      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     47      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     48      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
     48      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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SUBROUTINE STANG          73/73    OPT=1                         FTN 4.5+410          77/01/17. 11.07.10          PAGE     1

              SUBROUTINE STANG(NPT,NEL,ANG,T,XT,IN,XCPB,HMIN,ZTC,YT)                     DEC06      65
              DIMENSION  (20),Z(20),IW(20),X(3,1),XT(3,1),IN(4,1),XCPB(1)                STANG       3
        C.....IW(I)=NUMBER OF ELEMENTS IN THE ITH ROW.IF IW(I)=0,THIS NUMBER             STANG       4
        C.....IS COMPUTED TO OBTAIN APPROXIMATELY SQUARE ELEMENTS WHICH ARE A            STANG       5
        C.....MULTIPLE OF IW(I-1).                                                       STANG       6
              NPT1=NPT+1                                                                 NOV11      17
              CONVR=57.29577951                                                          STANG       7
              PIE=180./CONVR                                                             STANG       8
              READ(5,1004)NROWS,IANG,ISUP                                                DEC06      66
              XANG=IANG+1                                                                NOV11      19
         1004 FORMAT(4I5)                                                                NOV11      20
              WRITE(6,2040)                                                              STANG      11
         2040 FORMAT(1H0,50X,9HGRID SIZE/1H ,46X,1HR,11X,1HZ,4X,6HNUMBER)                 STANG      12
              SINE=SIN(ANG/CONVR)                                                        STANG      13
              COSE=COS(ANG/CONVR)                                                        STANG      14
              R(1)=Z(1)=0.0                                                              STANG      15
              NRWP=NROWS+1                                                               STANG      17
              NLR=0                                                                      DEC27      19
              DO 8 IB=2,NRWP                                                             STANG      18
              READ(5,1001)R(IB),Z(IB),IW(IB)                                             STANG      19
              WRITE(6,2041)R(IB),Z(IB),IW(IB)                                            STANG      20
              IF(IW(IB).LT.0)NLR=1                                                       DEC27      20
              IW(IB-1)=IABS(IW(IB))                                                      DEC27      21
              IF(NLR.EQ.1)GO TO 8                                                        DEC27      22
              IF(NPT1.NE.1)GO TO 8                                                       NOV11      21
              ZBL=Z(IB)*SINE-R(IB)*COSE                                                  STANG      22
              IF(ZBL.GE.-ZTC)GO TO 8                                                     NOV11      22
              ZTC=-ZBL                                                                   NOV11      23
              YT=Z(IB)*COSE+R(IB)*SINE                                                   STANG      25
            8 CONTINUE                                                                   STANG      26
              IW(1)=3*(IANG+1)                                                           NOV11      24
         1001 FORMAT(2F10.0,I5)                                                          STANG      29
         2041 FORMAT(1H ,37X,2(F10.6,4X),I5)                                             STANG      30
              DO 16 I=1,NROWS                                                            STANG      32
              IF(IW(I).GT.0)GO TO 15                                                     STANG      33
              AVG=(R(I)+R(I+1))/2.                                                       STANG      34
              SL=SQRT((R(I)-R(I+1))**2+(Z(I)-Z(I+1))**2)                                 STANG      35
              XW=PIE*AVG/SL+1.                                                           STANG      36
              IW(I)=XW*XANG                                                              NOV11      25
           15 CONTINUE                                                                   STANG      38
              IWH=IW(I)+1                                                                STANG      39
              XWH=IWH-1                                                                  STANG      40
              NGO=2                                                                      STANG      41
              IF(I.EQ.1)GO TO 16                                                         STANG      42
              IF(IW(I).EQ.IW(I-1))GO TO 16                                               STANG      43
              NGO=1                                                                      STANG      44
           16 CONTINUE                                                                   STANG      45
              DO 40 JK=NGO,2                                                             STANG      46
              ZZ=Z(I+JK-1)                                                               STANG      47
              RR=R(I+JK-1)                                                               STANG      48
              DO 30 K=1,IWH                                                              STANG      49
              XK=K-1                                                                     STANG      50
              AN=PIE*XK/XWH*XANG                                                         NOV11      26
              NPT=NPT+1                                                                  STANG      52
              X(3,NPT)=ZZ                                                                STANG      53
              X(2,NPT)=-COS(AN)*RR                                                       STANG      54
              X(1,NPT)=SIN(AN)*RR                                                        STANG      55
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SUBROUTINE STANG        73/73    OPT=1                          FTN 4.5+410        77/01/17. 11.07.10        PAGE     2

                   30 CONTINUE                                                        STANG       56
                   40 CONTINUE                                                        STANG       57
 60                10 CONTINUE                                                        STANG       58
                      SINE=SIN(ANG*PIE/180.)                                          STANG       59
                      COSE=COS(ANG*PIE/180.)                                          STANG       60
                      DO 20 I=NPT1,NPT                                                NOV11       27
                      XT(3,I)=X(3,I)*SINE-X(2,I)*COSE+ZTC-HMIN                        NOV08        4
 65                   XT(2,I)=X(3,I)*COSE+X(2,I)*SINE-YT                              STANG       63
                      XT(1,I)=X(1,I)                                                  STANG       64
                   20 CONTINUE                                                        STANG       65
                      IF(NPT1.NE.1)GO TO 52                                           NOV15        3
                      GZ= XCPB(3)*SINE-XCPB(2)*COSE+ZTC-HMIN                          STANG       68
 70                   GY=XCPB(3)*COSE+XCPB(2)*SINE-YT                                 STANG       69
                      XCPB(3)=GZ                                                      STANG       70
                      XCPB(2)=GY                                                      STANG       71
                   52 CONTINUE                                                        NOV15        4
                      IF(ISUP.EQ.1)GO TO 51                                           NOV03       24
 75                   IN(1,1)=1                                                       STANG       72
                      IN(2,1)=2                                                       STANG       73
                      IN(3,1)=3                                                       STANG       74
                      IN(4,1)=4                                                       STANG       75
                      NEL=NEL+1                                                       NOV11       28
 80                   IF(IANG.EQ.0)GO TO 51                                           NOV11       29
                      IN(1,2)=7                                                       NOV11       30
                      IN(2,2)=4                                                       NOV11       31
                      IN(3,2)=5                                                       NOV11       32
                      IN(4,2)=6                                                       NOV11       33
 85                   NEL=NEL+1                                                       NOV11       34
                   51 SUM=NPT1                                                        NOV11       35
                      DO 50 K=2,NROWS                                                 STANG       78
                      SUM=SUM+IW(K-1)+1                                               STANG       79
                      IF(IW(K).NE.IW(K-1))SUM=SUM+IW(K)+1                             STANG       80
 90                   SUMP=SUM-IW(K)-1                                                STANG       81
                      IWK=IW(K)                                                       STANG       82
                      DO 50 I=1,IWK                                                   STANG       83
                      NEL=NEL+1                                                       STANG       84
                      IN(1,NEL)=SUM+I-1                                               STANG       85
 95                   IN(2,NEL)=SUM+I                                                 STANG       86
                      IN(3,NEL)=SUMP+I                                                STANG       87
                   50 IN(4,NEL)=SUMP+I-1                                              STANG       88
                      RETURN                                                          STANG       89
                      END                                                             STANG       90
```

CARD NR.	SEVERITY	DETAILS	DIAGNOSIS OF PROBLEM
69	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
69	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
70	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
70	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
71	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
72	I	XCPB	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
81	I	IN	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
82	I	IN	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
83	I	IN	ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.

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        SUBROUTINE STANG       73/73   OPT=1                          FTN 4.5+410        77/01/17. 11.07.10        PAGE

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM
     84     I       IN       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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      SUBROUTINE OGIVG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)          DEC06    67
      DIMENSION X(3,1),XT(3,1),XCPB(3),IN(4,1),H(50),IW(50),B(50)       NOV23     1
C.....SUBROUTINE APPLICABLE TO AXISYMMETRIC BODIES WITH A POINTED NOSE.  NOV23     2
C.....USER PROVIDES GRID HEIGHT ON THE WINDWARD RAY OF THE BODY.        NOV23     3
C.....BODY ORIENTATION AND NUMBER OF ELEMENTS IN EACH ROW ARE ALSO      NOV23     4
C.....SPECIFIED.  NOTE- BODY SLOPE AT EACH RING MUST BE GREATER THAN    NOV23     5
C.....THAT OF THE BODY ORIENTATION.                                     NOV23     6
      COMMON/RAD/NBODY,R(50),Z(50)                                      NOV23     7
      NPT1=NPT+1                                                        NOV24     1
      IF(NPT1.EQ.1)ZTC=YTC=0.0                                          NOV23     9
      CONVR=57.29577951                                                 NOV23    10
      SINE=SIN(ANG/CONVR)                                               NOV23    11
      COSE=COS(ANG/CONVR)                                               NOV23    12
C.....READ IN DATA                                                      NOV23    13
      READ(5,1000)NROWS,NBODY,IANG                                      DEC06    68
      NROWS=NROWS+1                                                     NOV23    15
      XANG=IANG+1                                                       NOV23    16
 1000 FORMAT(4I5)                                                       NOV23    17
      WRITE(6,2000)IANG                                                 NOV23    18
 2000 FORMAT(1H0,40X,*SYMMETRY = *,I5)                                  NOV23    19
      READ(5,1001)(R(I),Z(I),I=1,NBODY)                                 NOV23    20
 1001 FORMAT(2F10.0)                                                    NOV23    21
      WRITE(6,2001)                                                     NOV23    22
 2001 FORMAT(1H ,50X,*BODY PROFILE*/1H ,46X,1HR,11X,1HZ)                NOV23    23
      WRITE(6,2002)(R(I),Z(I),I=1,NBODY)                                NOV23    24
 2002 FORMAT(1H ,37X,F10.6,4X,F10.6)                                    NOV23    25
      READ(5,1002)(H(I),B(I),IW(I),I=2,NROWS)                           NOV23    26
 1002 FORMAT(2F10.0,I5)                                                 NOV23    27
      WRITE(6,2003)                                                     NOV23    28
 2003 FORMAT(1H ,50X,9HGRID SIZE/1H ,46X,1HH,11X,1HB,4X,6HNUMBER)       NOV23    29
      WRITE(6,2004)(H(I),B(I),IW(I),I=2,NROWS)                          NOV23    30
 2004 FORMAT(1H ,37X,F10.6,4X,F10.6,4X,I5)                              NOV23    31
C.....CONSTRUCT NODES                                                   NOV23    32
      I=NBODY                                                           NOV23    33
      R(I+1)=1000.                                                      NOV23    35
      Z(I+1)=Z(I)+(Z(I)-Z(I-1))*(R(I+1)-R(I))/(R(I)-R(I-1))             NOV23    36
      H(1)=H(2)/1000.                                                   NOV23    37
      IW(1)=IW(2)                                                       NOV23    38
      B(1)=90.                                                          NOV23    39
      SGNP=1.                                                           NOV23    40
      RP1=RP2=0.0                                                       NOV24     2
      DO 10 I=1,NROWS                                                   NOV23    42
      TANB=TAN((90.-B(I))/CONVR)                                        NOV23    43
      XW=IW(I)                                                          NOV23    44
      IWK=IW(I)+1                                                       NOV23    45
      YO=RADIUS(H(I))                                                   NOV23    46
      ZO=H(I)                                                           NOV23    47
      SGN=1.                                                            NOV23    48
      RG=ZO                                                             NOV23    49
      ERR=ERR1=1.E-08                                                   NOV23    50
      DT=180.*XANG/(CONVR*XW)                                           NOV23    51
      DO 10 K=1,IWK                                                     NOV23    52
      DRG=RG/10.                                                        NOV23    53
      NPT=NPT+1                                                         NOV23    54
      XK=K-1                                                            NOV23    55
      IC=0                                                              NOV23    56
      ITP=0                                                             NOV23    57
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SUBROUTINE OGIVE      73/73    OPT=1                    FTN 4.5+410       77/01/17. 11.07.10      PAGE     2

           T=DT*XK                                                          NOV23      58
           COST=COS(T)                                                      NOV23      59
        14 RG=RG+SGN*DRG                                                    NOV23      60
        16 IC=IC+1                                                          NOV23      61
           IF(IC.GT.100)STOP                                                NOV23      62
           Y=-RG*COST                                                       NOV23      63
           ZZ=Z0+(Y-Y0)*TANB                                                NOV23      64
           ERR=RADIUS(ZZ)-RG                                                NOV23      65
           IF(ABS(ERR).LT.RG/10000.)GO TO 15                                NOV23      58
           SGNP=SGN                                                         NOV23      69
           SGN=1.                                                           NOV23      70
           IF(ERR.LT.0.0)SGN=-1.                                            NOV23      71
           RP2=RP1                                                          NOV23      73
           ERR2=ERR1                                                        NOV23      74
           RP1=RG                                                           NOV23      75
           ERR1=ERR                                                         NOV23      76
           IF(IC.EQ.1)GO TO 14                                              NOV23      77
           IF(ITP.EQ.1)GO TO 17                                             NOV23      78
           IF(ERR1*ERR2.GT.0.0)GO TO 14                                     NOV24       3
        17 ITP=1                                                            NOV23      80
           RG=RP1-(RP2-RP1)*ERR1/(ERR2-ERR1)                                NOV24       4
           GO TO 16                                                         NOV23      82
        15 X(1,NPT)=RG*SIN(T)                                               NOV23      83
           X(2,NPT)=Y                                                       NOV23      84
        10 X(3,NPT)=ZZ                                                      NOV23      85
           DO 21 I=NPT1,NPT                                                 NOV24       5
           XT(3,I)=X(3,I)*SINE-X(2,I)*COSE+ZTC-HMIN                         NOV23      87
           XT(2,I)=X(3,I)*COSE+X(2,I)*SINE-YTC                              NOV23      88
           XT(1,I)=X(1,I)                                                   NOV23      89
        21 CONTINUE                                                         NOV23      90
           IF(NPT1.NE.1)GO TO 52                                            NOV23      91
           GZ=XCPB(3)*SINE-XCPB(2)*COSE+ZTC-HMIN                            NOV23      92
           GY=XCPB(3)*COSE+XCPB(2)*SINE-YTC                                 NOV23      93
           XCPB(3)=GZ                                                       NOV23      94
           XCPB(2)=GY                                                       NOV23      95
        52 CONTINUE                                                         NOV23      96
           SUM=NPT1                                                         NOV23      97
           DO 50 K=2,NROWS                                                  NOV23      98
           SUM=SUM+IW(K-1)+1                                                NOV23      99
           IF(IW(K).NE.IW(K-1))SUM=SUM+IW(K)+1                              NOV23     100
           SUMP=SUM-IW(K)-1                                                 NOV23     101
           IWK=IW(K)                                                        NOV23     102
           DO 50 I=1,IWK                                                    NOV23     103
           NEL=NEL+1                                                        NOV23     104
           IN(1,NEL)=SUM+I-1                                                NOV23     105
           IN(2,NEL)=SUM+I                                                  NOV23     106
           IN(3,NEL)=SUMP+I                                                 NOV23     107
        50 IN(4,NEL)=SUMP+I-1                                               NOV23     108
           RETURN                                                           NOV23     109
           END                                                              NOV23     110
```

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FUNCTION RADIUS      73/73    OPT=1                    FTN 4.5+410        7~/01/17. 11.07.10        PAGE     1

              FUNCTION RADIUS(H)                                              NOV23     111
              COMMON/RAD/NBODY,R(50),Z(50)                                    NOV23     112
              RADIUS=0.0                                                      NOV23     113
              DO 10 I=1,NBODY                                                 NOV23     114
              FAC=(H-Z(I))*(H-Z(I+1))                                         NOV23     115
              IF(FAC.GT.0.0)GO TO 10                                          NOV23     116
              RADIUS=R(I)+(R(I+1)-R(I))*(H-Z(I))/(Z(I+1)-Z(I))                NOV23     117
              RETURN                                                          NOV24      10
           10 CONTINUE                                                        NOV23     118
              RETURN                                                          NOV23     119
              END                                                             OGIV6       3
```

```
SUBROUTINE LISTG       73/73    OPT=1                    FTN 4.5+410         77/01/17. 11.07.10        PAGE    1

         SUBROUTINE LISTG(NPT,NEL,ANG,X,XT,IN,XCPB,HMIN,ZTC,YTC)          DEC06     72
         DIMENSION X(3,1),XT(3,1),IN(4,1),XCPB(1)                          LISTG      3
   C.....ARBITRARY BODY GRID SUBROUTINE                                    LISTG      4
   C.....COORDINATES OF ALL NODES MUST BE PROVIDED                         LISTG      5
   C.....NODE GROUPS COMPOSING EACH ELEMENT MUST BE INPUT                  LISTG      6
         CONVR=57.29577951                                                 LISTG      7
         NPT1=NPT+1                                                        NOV11     39
         READ(5,1000)NP,NE                                                 DEC06     73
    1000 FORMAT(4I5)                                                       LISTG      9
   C.....READ NODE POINTS AND CALCULAT XT                                  LISTG     10
         SINE=SIN(ANG/CONVR)                                               LISTG     11
         COSE=COS(ANG/CONVR)                                               LISTG     12
         DO 10 I=1,NP                                                      NOV11     41
         NPT=NPT+1                                                         NOV11     42
    1001 FORMAT(3F10.0,I5)                                                 DEC27     23
         READ(5,1001)X(1,NPT),X(2,NPT),X(3,NPT),NLD                        DEC27     24
         XT(1,NPT)=X(1,NPT)                                                NOV11     44
         XT(2,NPT)=X(3,NPT)*COSE+X(2,NPT )*SINE                            NOV11     45
         XT(3,NPT)=X(3,NPT)*SINE-X(2,NPT)*COSE                             NOV11     46
         IF(NLD.GT.0)GO TO 10                                              DEC27     25
         IF(NPT1.NE.1)GO TO 10                                             NOV15    108
         IF(XT(3,I).GT.-ZTC)GO TO 10                                       NOV15    109
         YTC=XT(2,I)                                                       LISTG     20
         ZTC=-XT(3,I)                                                      NOV15    110
      10 CONTINUE                                                          LISTG     22
         DO 15 I=NPT1,NPT                                                  NOV11     47
         XT(3,I)=XT(3,I)+ZTC-HMIN                                          LISTG     25
      15 XT(2,I)=XT(2,I)-YTC                                               LISTG     26
         IF(NPT1.NE.1)GO TO 52                                             NOV15    111
         GZ=XCPB(3)*SINE-XCPB(2)*COSE+ZTC-HMIN                             LISTG     27
         GY=XCPB(3)*COSE+XCPB(2)*SINE-YTC                                  LISTG     28
         XCPB(3)=GZ                                                        LISTG     29
         XCPB(2)=GY                                                        LISTG     30
      52 CONTINUE                                                          NOV15    112
   C.....READ IN ELEMENTS                                                  LISTG     31
         DO 20 I=1,NE                                                      NOV11     48
         NEL=NEL+1                                                         NOV11     49
      20 READ(5,1000)IN(1,NEL),IN(2,NEL),IN(3,NEL),IN(4,NEL)               NOV11     50
         RETURN                                                            LISTG     34
         END                                                               LISTG     35

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

   30       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   30       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   31       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   31       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   32       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   33       I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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SUBROUTINE GRID        73/73    OPT=1                          FTN 4.5+410        77/01/17. 11.07.10        PAGE     1

                SUBROUTINE GRID(NPT,NEL,X,XT,IN,PHIO,XC,ACHECK,NNLD)                   DEC14      11
                DIMENSION X(3,1),XT(3,1),IN(4,1),XC(3,1),PHIO(2,1)                     GRID        3
          C.....PRINT NODES                                                            GRID        4
                WRITE(6,2006)                                                          GRID        5
           2006 FORMAT(1H0,13X,5HNODE ,10X,1HX,8X,1HY,8X,1HZ,9X,2HXP,8X,2HYP,8X,      GRID        6
               *2HZP)                                                                  GRID        7
                DO 5 I=1,NPT                                                           GRID        8
              5 WRITE(6,2007)I,(X(J,I),J=1,3),(XT(J,I),J=1,3)                          GRID        9
           2007 FORMAT(1H ,10X,I5,5X,6(2X,F8.4))                                       GRID       10
                WRITE(6,2008)                                                          GRID       11
           2008 FORMAT(1H0,15X,7HELEMENT,7X,1H1,9X,1H2,9X,1H3,9X,1H4,7X,2HXC,7X,      NOV03      26
               *2HYC,7X,2HZC,7X,2HRC,8X,2HTC,7X,4HAREA/1H )                            NOV03      27
                CALL CENT(X,XC,IN,NEL,PHIO)                                            GRID       13
          C.....PRINT ELEMENT NODES,AREA,AND CENTROIDS                                 GRID       14
                ACHECK=0.0                                                             NOV15     114
                DO 10 I=1,NEL                                                          GRID       15
                IF(I.EQ.NNLD)WRITE(6,2010)                                             DEC14      12
                ACHECK=ACHECK+PHIO(2,I)                                                NOV15     115
                R=SQRT(XC(1,I)**2+XC(2,I)**2)                                          NOV03      28
                ANGLE=57.2957795*ATAN2(XC(1,I),XC(2,I))                                NOV02       4
             10 WRITE(6,2009)I,(IN(J,I),J=1,4),(XC(J,I),J=1,3),R,ANGLE,PHIO(2,I)       NOV03      29
           2009 FORMAT(1H ,10X,5(5X,I5),4(2X,F8.5),2X,F8.3,E12.4)                      NOV03      30
                ACHECK=SQRT(ACHECK/FLOAT(NEL))/1000.                                   NOV15     116
                RETURN                                                                 GRID       20
           2010 FORMAT(1H0,30X,*NO LOAD ELEMENTS*)                                     DEC14      13
                END                                                                    GRID       21
```

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SUBROUTINE ADVN       73/73    OPT=1                    FTN 4.5+410        77/01/17. 11.07.10        PAGE    1

 1              SUBROUTINE ADVN(XT,VEZ,VEY,VEX,CWT,WX,ANG,XCPB,IS,NPT,DT,          ADVN       2
               *DDZ,HMAX)                                                          ADVN       3
          C.....SUBROUTINE MOVES NODES FORWARD IN TIME                             ADVN       4
          C.....THE SPLASH HEIGHT,DELTA H*(CWT(I)-1.) IS BASED ON THE DELTA        ADVN       5
 5        C     H OF THE DEEPEST POINT.                                            ADVN       6
                DIMENSION XT(3,1),VEZ(1),VEY(1),VEX(1),CWT(1),WX(1),XCPB(1),DT(1)  ADVN       7
                CONVR=57.29577951                                                  NOV03     31
                DDT=DT(IS)                                                         ADVN       8
                CW=CWT(IS)                                                         ADVN       9
10              VSX=VEX(IS)                                                        ADVN      11
                VSY=VEY(IS)                                                        ADVN      12
                VSZ=VEZ(IS)                                                        ADVN      13
                ZDEEP=1000.                                                        NOV05      6
                DG=WX(IS)*DDT                                                      NOV03     32
15              ANG=ANG+DG                                                         NOV03     33
                SIND=SIN(DG/CONVR)                                                 NOV03     34
                COSD=COS(DG/CONVR)                                                 NOV03     35
                DO 10 I=1,NPT                                                      ADVN      15
                ZP=XT(3,I)-XCPB(3)                                                 NOV03     37
20              YP=XT(2,I)-XCPB(2)                                                 NOV03     38
                DZ=DDT*VSZ-ZP*(1.-COSD)+YP*SIND                                    NOV05      7
                XT(3,I)=XT(3,I)+DZ                                                 NOV03     40
                ZCH=XT(3,I)                                                        ADVN      17
                XT(2,I)=XT(2,I)+VSY*DDT-YP*(1.-COSD)-ZP*SIND                       NOV08      5
25              XT(1,I)=XT(1,I)+DDT*VSX                                            ADVN      20
                IF(ZCH.GT.ZDEEP)GO TO 10                                           ADVN      21
                ZDEEP=ZCH                                                          ADVN      22
                DDZ=DZ*(1.-CW)                                                     NOV03     42
                HMAX=DDZ-XT(3,I)                                                   NOV05      9
30           10 CONTINUE                                                           ADVN      25
                DO 15 I=1,NPT                                                      ADVN      26
                XT(3,I)=XT(3,I)-DDZ                                                NOV03     44
             15 CONTINUE                                                           NOV05     10
                XCPB(3)=XCPB(3)+VSZ*DDT-DDZ                                        NOV03     47
35              XCPB(2)=XCPB(2)+VSY*DDT                                            ADVN      29
                XCPB(1)=XCPB(1)+VSX*DDT                                            ADVN      30
                RETURN                                                             ADVN      31
                END                                                                ADVN      32

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

   19      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   20      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   34      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   34      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   35      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   35      I       XCPB      ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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SUBROUTINE CREL      73/73    OPT=1                         FTN 4.5+410        77/01/17. 11.07.10        PAGE    1

            SUBROUTINE CREL(X,IN,IT,IC,IM,IEM,NPT,NEL,ANG,INP,XT,XCPB,CGL,    NOV15     117
           *ACHECK)                                                           NOV15     118
            DIMENSION X(3,1),IN(4,1),IT(4,1),IQ(1),IM(1),I(4),XT(3,1),XCPB(3) JAN01       6
            CONVR=57.29577951                                                 NOV03      50
            IEM=0                                                             CREL        7
            INP=NPT                                                           CREL        8
            DO 5 K=1,NEL                                                      CREL        9
            ITOT=0                                                            CREL       10
            ITOTC=0                                                           DEC12       2
            SUM=X(1,IN(1,K))+X(1,IN(2 ,K))+X(1,IN(3,K))+X(1,IN(4,K))          NOV11      51
      C.....COUNT NUMBER OF POINT BELOW SURFACE                               NOV11      52
            DO 10 J=1,4                                                       CREL       11
            I(J)=0                                                            CREL       12
            II=IN(J,K)                                                        CREL       13
            IF(XT(3,II).GT.0.0)I(J)=1                                         DEC12       3
            IF(XT(3,II).GT.-ACHECK)ITOTC=ITOTC+1                              DEC12       4
            IF(I(J).EQ.0)IF=J                                                 CREL       15
            IF(I(J).EQ.1)JF=J                                                 CREL       16
         10 ITOT=ITOT+I(J)                                                    CREL       17
      C.....IF ALL POINTS ARE ABOVE WATER SURFACE DISCARD ELEMENT.            NOV11      53
            IF(ITOT.EQ.4)GO TO 5                                              CREL       18
            IF(ITOTC.EQ.4)GO TO 5                                             DEC12       5
            IEM=IEM+1                                                         CREL       19
            IM(IEM)=0                                                         CREL       20
            IQ(IEM)=K                                                         CREL       21
            DO 15 L=1,4                                                       CREL       22
         15 IT(L,IEM)=IN(L,K)                                                 CREL       23
      C.....IF ALL POINTS ARE BELOW THE WATER USE ELEMENTS AS IS.             NOV11      54
            IF(ITOT.EQ.0)GO TO 5                                              CREL       24
            IM(IEM)=1                                                         CREL       25
      C.....DETERMINE NODES BOUNDING ELEMENT SIDES INTERSECTED BY THE SURFACE. NOV11     55
            DO 25 L=1,4                                                       CREL       26
            LM=L+1                                                            CREL       27
            IF(L.EQ.4)LM=1                                                    CREL       28
            IF(I(L)+I(LM).NE.1)GO TO 25                                       CREL       29
            IG=L                                                              CREL       30
            IB=LM                                                             CREL       31
            IF(I(L).EQ.0 )GO TO 30                                            CREL       32
            IG=LM                                                             CREL       33
            IB=L                                                              CREL       34
         30 IIG=IN(IG,K)                                                      CREL       35
            IIB=IN(IB,K)                                                      CREL       36
            INP=INP+1                                                         CREL       37
            XT(3,INP)=0.0                                                     CREL       38
            RATIO=-XT(3,IIG)/(XT(3,IIB)-XT(3,IIG))                            CREL       39
            XT(2,INP)=XT(2,IIG)+RATIO*(XT(2,IIB)-XT(2,IIG))                   CREL       40
            XT(1,INP)=XT(1,IIG)+RATIO*(XT(1,IIB)-XT(1,IIG))                   CREL       41
            IT(IB,IEM)=INP                                                    CREL       42
         25 CONTINUE                                                          CREL       43
      C.....IF TWO NODES ARE SUBMERGED NEW ELEMENT COMPLETE.                  NOV11      56
            IF(ITOT.EQ.2)GO TO 5                                              CREL       44
            IF(ITOT.EQ.1)GO TO 6                                              CREL       45
      C.....ONLY ONE NODE SUBMERGED                                           NOV11      57
            IP1= IF+1                                                         CREL       46
            IP2=IF-1                                                          CREL       47
            IF(IP1.EQ.5)IP1=1                                                 CREL       48
            IF(IP2.EQ.0)IP2=4                                                 CREL       49
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SUBROUTINE CREL        73/73    OPT=1                          FTN 4.5+410       77/01/17. 11.07.10       PAGE     2

           M1=IT(IP1,IEM)                                                         CREL       50
           M2=IT(IP2,IEM)                                                         CREL       51
           INP=INP+1                                                              CREL       52
           DO 9 JS=1,3                                                            CREL       53
           XT(JS,INP)=(XT(JS,M1)+XT(JS,M2))/2.                                    CREL       54
         9 CONTINUE                                                               CREL       55
           IP3=IP1+1                                                              CREL       56
           IF(IP3.EQ.5)IP3=1                                                      CREL       57
           IT(IP3,IEM)=INP                                                        CREL       58
           GO TO 5                                                                CREL       59
     C.....THREE SUBMERGED POINTS                                                 NOV11      58
         6 JF1=JF+1                                                               CREL       60
           IF(JF1.EQ.5)JF1=1                                                      CREL       61
           JF2=JF1+1                                                              CREL       62
           IF(JF2.EQ.5)JF2=1                                                      CREL       63
           JF3=JF2+1                                                              CREL       64
           IF(JF3.EQ.5)JF3=1                                                      CREL       65
           IF(SUM.LT.0.0)GO TO 45                                                 NOV11      59
           IT(JF,IEM)=INP-1                                                       CREL       66
           IT(JF1,IEM)=INP+1                                                      CREL       67
           IEM=IEM+1                                                              CREL       68
           IT(JF,IEM)=INP                                                         CREL       69
           IT(JF1,IEM)=IN(JF1,K)                                                  CREL       70
           IT(JF2,IEM)=INP+1                                                      CREL       71
           IT(JF3,IEM)=INP-1                                                      CREL       72
           IP1=IN(JF1,K)                                                          CREL       73
           IP2=IN(JF2,K)                                                          CREL       74
           GO TO 50                                                               NOV11      60
        45 IT(JF,IEM)=INP                                                         NOV11      61
           IT(JF3,IEM)=INP+1                                                      NOV11      62
           IEM=IEM+1                                                              NOV11      63
           IT(JF,IEM)=INP                                                         NOV11      64
           IT(JF1,IEM)=INP+1                                                      NOV11      65
           IT(JF2,IEM)=IN(JF3,K)                                                  NOV11      66
           IT(JF3,IEM)=INP-1                                                      NOV11      67
           IP1=IN(JF2,K)                                                          NOV11      68
           IP2=IN(JF3,K)                                                          NOV11      69
        50 CONTINUE                                                               NOV11      70
           INP=INP+1                                                              CREL       75
           IQ(IEM)=K                                                              CREL       76
           IM(IEM)=2                                                              CREL       77
           DO 8 LK=1,3                                                            CREL       78
           XT(LK,INP)=(XT(LK,IP1)+XT(LK,IP2))/2.                                  CREL       79
         8 CONTINUE                                                               CREL       80
           IF(JF.NE.1)GO TO 5                                                     CREL       81
           DO 41 JGG=1,3                                                          CREL       82
           XLK=XT(JGG,INP-1)                                                      CREL       83
           XT(JGG,INP-1)=XT(JGG,INP-2)                                            CREL       84
        41 XT(JGG,INP-2)=XLK                                                      CREL       85
         5 CONTINUE                                                               CREL       86
     C.....TRANSFORM GENERATED NODES TO WATER COORDINATES.                        NOV11      71
           IF(NPT.EQ.INP)RETURN                                                   DEC15       3
           SINE=SIN(ANG/CONVR)                                                    CREL       87
           COSE=COS(ANG/CONVR)                                                    CREL       88
           NPT1=NPT+1                                                             CREL       89
           DO 20 K=NPT1,INP                                                       CREL       90
           ZPT=XT(3,K)-XCPB(3)                                                    NOV03      51
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SUBROUTINE CREL        73/73   OPT=1                       FTN 4.5+410      77/01/17. 11.07.10      PAGE     3

                 YPT=XT(2,K)-XCPB(2)                                         NOV03       52
                 X(3,K)=ZPT*SINE+YPT*COSE+CGL                                NOV02       11
                 X(2,K)=-ZPT*COSE+YPT*SINE                                   CREL        94
              20 X(1,K)=XT(1,K)                                              CREL        95
                 RETURN                                                      CREL        96
                 END                                                         CREL        97
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SUBROUTINE MAN        73/73    OPT=1                        FTN 4.5+410        77/01/17. 11.37.10        PAGE    1

          SUBROUTINE MAN(X,IT,XT,XC,XCP,IEM,ANG,PHIO,IQ,XCPB,CGL,E)        NOV05      11
          DIMENSIONX(3,1),IT(4,1),XT(3,1),XC(3,1),XCP(3,1),E(3,3,1),F(3)   MAN         3
         1,G(3),XCPB(3),PHIO(2,1),IQ(1)                                    MAN         4
          CONVR=57.29577951                                                MAN         5
          SINE=SIN(ANG/CONVR)                                              MAN         6
          COSE=COS(ANG/CONVR)                                              MAN         7
          CALL CENT(XT,XCP,IT,IEM,PHIO)                                    NOV03      54
          DO 10 K=1,IEM                                                    MAN         9
          I1=IT(1,K)                                                       MAN        10
          I2=IT(2,K)                                                       MAN        11
          I3=IT(3,K)                                                       MAN        12
          I4=IT(4,K)                                                       MAN        13
C.....TRANSFORM CENTROID TO BODY COORDINATES                               MAN        14
          ZPT=XCP(3,K)-XCPB(3)                                             MAN        15
          YPT=XCP(2,K)-XCPB(2)                                             MAN        16
          XC(1,K)=XCP(1,K)                                                 MAN        17
          XC(2,K)=-ZPT*COSE+YPT*SINE                                       MAN        18
          XC(3,K)=ZPT*SINE+YPT*COSE+CGL                                    MAN        19
          DO 20 L=1,3                                                      MAN        20
          F(L)=XT(L,I3)-XT(L,I1)                                           MAN        21
       20 G(L)=XT(L,I2)-XT(L,I4)                                           MAN        22
          DEL1=SQRT(F(1)*F(1)+F(2)*F(2)+F(3)*F(3))                         MAN        23
          DEL2=SQRT(G(1)*G(1)+G(2)*G(2)+G(3)*G(3))                         MAN        24
          DO 25 L=1,3                                                      MAN        25
          E(L,1,K)=F(L)/DEL1                                               MAN        26
       25 E(L,2,K)=G(L)/DEL2                                               MAN        27
          F(1)=E(2,1,K)*E(3,2,K)-E(3,1,K)*E(2,2,K)                         MAN        28
          F(2)=E(3,1,K)*E(1,2,K)-E(1,1,K)*E(3,2,K)                         MAN        29
          F(3)=E(1,1,K)*E(2,2,K)-E(1,2,K)*E(2,1,K)                         MAN        30
          DEL=SQRT(F(1)*F(1)+F(2)*F(2)+F(3)*F(3))                          MAN        31
          DO 30 L1=1,3                                                     MAN        32
       30 E(L1,3,K)=F(L1)/DEL                                              MAN        33
          E(1,2,K)=E(2,3,K)*E(3,1,K)-E(2,1,K)*E(3,3,K)                     MAN        34
          E(2,2,K)=E(1,1,K)*E(3,3,K)-E(1,3,K)*E(3,1,K)                     MAN        35
          E(3,2,K)=E(1,3,K)*E(2,1,K)-E(1,1,K)*E(2,3,K)                     MAN        36
       10 CONTINUE                                                         MAN        37
          RETURN                                                           MAN        38
          END                                                              MAN        39
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SUBROUTINE ELEMST     73/73   OPT=1                     FTN 4.5+410       77/01/17. 11.07.10       PAGE    1

            SUBROUTINE ELEMST(INP,NPT,IT,IEM,IQ,IM,X,XT,XC,XCP,E,PHIO,ISTEP,H) ELEMST    2
            DIMENSION X(3,1),XT(3,1),IT(4,1),PHIO(2,1),XC(3,1),XCP(3,1),        ELEMST    3
           *IQ(1),IM(1),E(3,3,1)                                                ELEMST    4
            WRITE(6,2030)ISTEP,H                                                ELEMST    5
       2030 FORMAT(1H1,30X,5HSTEP ,I5,2X,6HDEPTH ,F10.7)                        ELEMST    6
       2010 FORMAT(1H0,10X,15HGENERATED NODES)                                  ELEMST    7
            NPT1=NPT+1                                                          ELEMST    8
            WRITE(6,2010)                                                       NOV03    55
            WRITE(6,2006)                                                       ELEMST    9
            DO 25 I=NPT1,INP                                                    ELEMST   10
         25 WRITE(6,2007)I,(X(J,I),J=1,3),(XT(J,I),J=1,3)                       ELEMST   11
            WRITE(6,2011)                                                       ELEMST   12
            WRITE(6,2008)                                                       ELEMST   13
       2011 FORMAT(1H0,10X,12HRUN ELEMENTS)                                     ELEMST   14
            DO 30 I=1,IEM                                                       ELEMST   15
         30 WRITE(6,2009)I,(IT(J,I),J=1,4)                                      ELEMST   16
            WRITE(6,2019)                                                       ELEMST   17
       2019 FORMAT(1H1,15X,18HELEMENT STATISTICS)                               ELEMST   18
            DO 35 I=1,IEM                                                       ELEMST   19
            IF(PHIO(1,IQ(I)).GT.0.0)GO TO 35                                    ELEMST   20
            IF(IM(I).EQ.0)PHIO(1,IQ(I))=1.                                      ELEMST   21
            WRITE(6,2012)I,IQ(I),IM(I),(XC(J,I),J=1,3),(XCP(JR,I),JR=1,3)       ELEMST   22
       2012 FORMAT(1H0,12HELEMENT NO. ,I5,5X,14HREFERENCE NO. ,I5,5X,           ELEMST   23
           218HMODIFICATION CODE ,I5/1H ,10X,12HCENTROIDE X ,3(F8.4,2X),2HXP,   ELEMST   24
           33(2X,F8.4))                                                         ELEMST   25
            WRITE(6,2013)                                                       ELEMST   26
       2013 FORMAT(1H0,5X,6HCORNER,7X,4HNODE,9X,1HX,9X,1HY,9X,1HZ,9X,2HXP,      ELEMST   27
           29X,2HYP,8X,2HZP)                                                    ELEMST   28
            DO 45 K=1,4                                                         ELEMST   29
            I1=IT(K,I)                                                          ELEMST   30
         45 WRITE(6,2016)K,I1,(X(K1,I1),K1=1,3),(XT(K2,I1),K2=1,3)              ELEMST   31
       2016 FORMAT(1H ,5X,2(I5,5X),6(F8.4,2X))                                  ELEMST   32
            WRITE(6,2017)PHIO(2,I)                                              ELEMST   33
       2017 FORMAT(1H0,5X,6HVECTOR,8X,1H1,8X,1H2,9X,1H3,20X,7HAREA = ,F12.7)    ELEMST   34
            DO 50 K=1,3                                                         ELEMST   35
         50 WRITE(6,2018)K,(E(JR,K,I),JR=1,3)                                   ELEMST   36
       2018 FORMAT(1H ,8X,I5,3(2X,F8.4))                                        ELEMST   37
         35 CONTINUE                                                            ELEMST   38
            RETURN                                                              ELEMST   40
       2006 FORMAT(1H0,13X,5HNODE ,10X,1HX,8X,1HY,8X,1HZ,9X,2HXP,8X,2HYP,8X,    NOV03    56
           *2HZP)                                                               ELEMST   42
       2007 FORMAT(1H ,10X,I5,5X,6(2X,F8.4))                                    ELEMST   43
       2008 FORMAT(1H0,15X,7HELEMENT,9X,1H1,9X,1H2,9X,1H3,9X,1H4/1H )           ELEMST   44
       2009 FORMAT(1H ,10X,5(5X,I5),4(2X,F8.5),2X,F8.3)                         ELEMST   45
            END                                                                 ELEMST   46
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SUBROUTINE VNORM       73/73    OPT=1                      FTN 4.5+410        77/01/17. 11.07.16        PAGE     1

 1              SUBROUTINE VNORM(VEZ,VEY,VEX,WX,VNO,E,IEM,ISTEP,XCP,XCPB,IPRINT)   NOV08      12
                DIMENSION VEZ(1),VEY(1),VEX(1),WX(1),VNO(1),E(3,3,1),XCP(3,1),     VNORM       3
               *XCPB(1)                                                             VNORM       4
                CONVR=57.29577951                                                   NOV08      13
 5              VZ=(VEZ(ISTEP)+VEZ(ISTEP+1))/2.                                     VNORM       5
                VY=(VEY(ISTEP)+VEY(ISTEP+1))/2.                                     VNORM       6
                VX=(VEX(ISTEP)+VEX(ISTEP+1))/2.                                     VNORM       7
                WXX=(WX(ISTEP)+WX(ISTEP+1))/2.                                      VNORM       8
                IF(IPRINT.EQ.1)WRITE(6,2000)VX,VY,VZ,WXX                            NOV08      14
 10             DO 5 I=1,IEM                                                        VNORM       9
                VZC=VZ+WXX*(XCP(2,I)-XCPB(2))/CONVR                                 NOV08      15
                VYC=VY-WXX*(XCP(3,I)-XCPB(3))/CONVR                                 NOV08      16
              5 VNO(I)=VZC*E(3,3,I)+VYC*E(2,3,I)+VX*E(1,3,I)                        NOV05      12
                RETURN                                                              VNORM      13
 15        2000 FORMAT(1H1,10X,*VX = *,F10.3,*  VY = *,F10.3,*  VZ = *,F10.3,       NOV08      17
               **  WX = *,F10.2)                                                    NOV08      18
                END                                                                 VNORM      14

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

   11       I      XCPB       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   12       I      XCPB       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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SUBROUTINE AMAT       73/73    OPT=1                         FTN 4.5+410       77/01/17. 11.07.10        PAGE     1

      SUBROUTINE AMAT(XCP,XT,IT,IEM,A,AY,AX,PHI,VNO,F,IPHI)              NOV09      2
      DIMENSION XCP(3,1),XT(3,1),PHI(1),VNO(1),A(1),AX(1),AY(1),         AMAT       3
     *IT(4,1),E(3,3,1)                                                    AMAT       4
      DIMENSION F(3),XI(3,4),XP(3),C(4),D(4),CS(4),Q(4),CR(4),R(4),      AMAT       5
     2S(2,4),XJ(4),V(3),VI(3),X(3)                                        AMAT       6
      DIMENSION XCPI(3),EI(3,3),XTI(3,4)                                  AMAT       7
      PIE=3.14159265                                                      AMAT       8
      IXXN=3-IPHI                                                         NOV09      3
      IPHC=2-IPHI                                                         NOV09      4
      CONVR=180./PIE                                                      AMAT       9
      DO 5 J=1,IEM                                                        AMAT      10
      DO 2 I=1,IEM                                                        AMAT      11
    2 A(I)=AX(I)=AY(I)=PHI(I)=0.0                                         AMAT      12
      DO 41 I=1,3                                                         AMAT      13
      XCPI(I)=XCP(I,J)                                                    AMAT      14
      DO 42 K=1,3                                                         AMAT      15
   42 EI(K,I)=E(K,I,J)                                                    AMAT      16
      DO 41 L=1,4                                                         AMAT      17
   41 XTI(I,L)=XT(I,IT(L,J))                                              AMAT      18
      DO 6 IX=1,IXXN                                                      NOV09      5
      DO 7 IZ=1,2                                                         AMAT      20
C.....CALCULATE NODE LOCATION IN ELEMENT COORDINATES                     AMAT      21
      DO 11 L=1,4                                                         AMAT      22
      DO 10 K=1,3                                                         AMAT      23
   10 F(K)=XTI(K,L)-XCPI(K)                                               AMAT      24
      DO 11 IR=1,3                                                        AMAT      25
   11 XI(IR,L)=F(1)*EI(1,IR)+F(2)*EI(2,IR)+F(3)*EI(3,IR)                 AMAT      26
      DSI=XI(1,3)-XI(1,1)                                                 AMAT      27
      DNU=XI(2,3)-XI(2,1)                                                 AMAT      28
      DSN=XI(2,2)-XI(2,4)                                                 AMAT      29
      XI00=DSI*DSN*.5                                                     AMAT      30
      DCH2=DSI*DSI+DNU*DNU                                                AMAT      31
      HLTI=(XI(1,2)-XI(1,4))**2+DSN*DSN                                   AMAT      32
      IF(DCH2.LT.HLTI)DCH2=HLTI                                           AMAT      33
      C1=XI(1,1)+XI(1,2)+XI(1,3)                                          NOV09      6
      C2=XI(1,1)*(XI(1,1)+XI(1,3))+XI(1,3)*XI(1,3)                        NOV09      7
      C3=XI(1,4)+C1                                                       NOV09      8
      C4=C3-XI(1,2)                                                       NOV09      9
      XI20=DSI/12.*(XI(2,1)*(XI(1,4)-XI(1,2))*C3+C2*(XI(2,2)-XI(2,4))    NOV09     10
     *+XI(1,2)*XI(2,2)*C1-XI(1,4)*XI(2,4)*C4)                             NOV09     11
      C1=(XI(2,1)-XI(2,4))*(XI(2,1)+XI(2,4))                              NOV09     12
      C2=(XI(2,1)-XI(2,2))*(XI(2,1)+XI(2,2))                              NOV09     13
      C3=2.*XI(2,1)+XI(2,2)+XI(2,4)                                       NOV09     14
      XI11=DSI/24.*(2.*XI(1,4)*C1-2.*XI(1,2)*C2+(XI(1,1)+XI(1,3))*       NOV09     15
     1DSN*C3)                                                             NOV09     16
      C2=XI(2,2)+XI(2,4)                                                  NOV09     17
      C1=(XI(2,1)+C2)**2                                                  NOV09     18
      XI02=XI00/6.*(C1-XI(2,1)*C2-XI(2,2)*XI(2,4))                        NOV09     19
      DO 27 K=1,4                                                         AMAT      34
      K1=K+1                                                              AMAT      35
      IF(K.EQ.4)K1=1                                                      AMAT      36
      D(K)=SQRT((XI(1,K1)-XI(1,K))**2+(XI(2,K1)-XI(2,K))**2)              AMAT      37
      C(K)=(XI(1,K1)-XI(1,K))/D(K)                                        AMAT      38
   27 CS(K)=(XI(2,K1)-XI(2,K))/D(K)                                       AMAT      39
      DO 45 I=1,IEM                                                       AMAT      40
C.....DETERMINE POINT AT WHICH VELOCITY IS INDUCED IN ELEMENT COORDINATE AMAT      41
      DO 15 K=1,3                                                         AMAT      42
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      15 X(K)=XCP(K,I)-XCPI(K)                                  AMAT      43
         R02=X(1)*X(1)+X(2)*X(2)+X(3)*X(3)                      AMAT      44
         IF(R02/DCH2.LE.16.)GO TO 70                            AMAT      45
         DO 21 K=1,3                                            AMAT      46
      21 XP(K)=X(1)*E(1,K,I)+X(2)*E(2,K,I)+X(3)*E(3,K,I)        AMAT      47
         R0=SQRT(R02)                                           AMAT      48
         PH=XI00/R0                                             AMAT      49
         FAC=PH/R02                                             AMAT      50
         VI(1)=XP(1)*FAC                                        AMAT      51
         VI(2)=XP(2)*FAC                                        AMAT      52
         VI(3)=XP(3)*FAC                                        AMAT      53
         GO TO 71                                               AMAT      54
      70 CONTINUE                                               AMAT      55
         DO 20 K=1,3                                            AMAT      56
      20 XP(K)=X(1)*EI(1,K)+X(2)*EI(2,K)+X(3)*EI(3,K)           AMAT      57
C.....CALCULATE INDUCED VELOCITIES                              AMAT      58
         IF(R02/DCH2.LE.6)GO TO 72                              NOV09     20
C.....MULTIPOLE EXPANSION                                       NOV09     21
         R02=1./R02                                             NOV09     22
         R01=SQRT(R02)                                          NOV09     23
         R03=R01*R02                                            NOV09     24
         R05=R02*R03                                            NOV09     25
         R07=R05*R02                                            NOV09     26
         XX=XP(1)                                               NOV09     27
         YY=XP(2)                                               NOV09     28
         ZZ=XP(3)                                               NOV09     29
         XX2=XX*XX                                              NOV09     30
         YY2=YY*YY                                              NOV09     31
         ZZ2=ZZ*ZZ                                              NOV09     32
         PP=YY2+ZZ2-4.*XX2                                      NOV09     33
         QQ=XX2+ZZ2-4.*YY2                                      NOV09     34
         WX=-XX*R03                                             NOV09     35
         WY=-YY*R03                                             NOV09     36
         WZ=-ZZ*R03                                             NOV09     37
         WXX=-(PP+2.*XX2)*R05                                   NOV09     38
         WXY=3.*XX*YY*R05                                       NOV09     39
         WYY=-(QQ+2.*YY2)*R05                                   NOV09     40
         WXXX=3.*XX*(3.*PP+10.*XX2)*R07                         NOV09     41
         WXXY=3.*YY*PP*R07                                      NOV09     42
         WXYY=3.*XX*QQ*R07                                      NOV09     43
         WYYY=3.*YY*(3.*QQ+10.*YY2)*R07                         NOV09     44
         WXXZ=3.*ZZ*PP*R07                                      NOV09     45
         WXYZ=-15.*XX*YY*ZZ*R07                                 NOV09     46
         WYYZ=3.*ZZ*QQ*R07                                      NOV09     47
         PH=XI00*R01+.5*(XI20*WXX+2.*XI11*WXY+XI02*WYY)         NOV09     48
         V(1)=-XI00*WX-.5*(XI20*WXXX+2.*XI11*WXXY+XI02*WXYY)    NOV09     49
         V(2)=-XI00*WY-.5*(XI20*WXXY+2.*XI11*WXYY+XI02*WYYY)    NOV09     50
         V(3)=-XI00*WZ-.5*(XI20*WXXZ+2.*XI11*WXYZ+XI02*WYYZ)    NOV09     51
         GO TO 73                                               NOV09     52
      72 CONTINUE                                               NOV09     53
C.....COMPLETE FORMULAS                                         NOV09     54
         DO 25 K=1,4                                            AMAT      59
         K1=K+1                                                 AMAT      60
         IF(K.EQ.4)K1=1                                         AMAT      61
         S(1,K)=(XI(1,K)-XP(1))*C(K)+(XI(2,K)-XP(2))*CS(K)      AMAT      62
         S(2,K)=(XI(1,K1)-XP(1))*C(K)+(XI(2,K1)-XP(2))*CS(K)    AMAT      63
         CR(K)=(XP(1)-XI(1,K))*CS(K)-(XP(2)-XI(2,K))*C(K)       AMAT      64
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SUBROUTINE AMAT       73/73    OPT=1                      FTN 4.5+410        77/01/17. 11.07.10        PAGE     3

           R(K)=SQRT((XP(1)-XI(1,K))**2+(XP(2)-XI(2,K))**2+XP(3)**2)          AMAT      65
        25 CONTINUE                                                            AMAT      66
           V(1)=0.0                                                            AMAT      67
           V(2)=0.0                                                            AMAT      68
           V(3)=0.0                                                            AMAT      69
           AZ=ABS(XP(3))                                                       AMAT      70
           AS=-1.                                                              AMAT      71
           IF(XP(3).GE.0.0)AS=1.                                               AMAT      72
           PH=0.5                                                              AMAT      73
           DO 30 K=1,4                                                         AMAT      74
           K1=K+1                                                              AMAT      75
           IF(K.EQ.4)K1=1                                                      AMAT      76
           Q(K)=ALOG((R(K)+R(K1)+D(K))/(R(K)+R(K1)-D(K)))                      AMAT      77
           XJ(K)=0.0                                                           AMAT      78
           IF(CR(K).EQ.0.0)GO TO 61                                            AMAT      79
           FT=ABS(XP(3)/CR(K))                                                 AMAT      80
           XJ(K)=ABS(CR(K))/CR(K)*(ATAN(FT*S(2,K)/R(K1))-ATAN(FT*S(1,K)/       AMAT      81
          2R(K)))                                                              AMAT      82
        61 CONTINUE                                                            AMAT      83
           PH=PH+AZ*XJ(K)+CR(K)*Q(K)                                           AMAT      84
           V(1)=V(1)-CS(K)*Q(K)                                                AMAT      85
           V(2)=V(2)+C(K)*Q(K)                                                 AMAT      86
        30 V(3)=V(3)-XJ(K)                                                     AMAT      87
           DTH=2.*PIE                                                          AMAT      88
           ICRT=0                                                              AMAT      89
           DO 46 KU=1,4                                                        AMAT      90
           IF(CR(KU).GT.0.0)ICRT=1+ICRT                                        AMAT      91
        46 CONTINUE                                                            AMAT      92
           IF(ICRT.LT.4)DTH=0.0                                                AMAT      93
           PH=PH-AZ*DTH                                                        AMAT      94
           V(3)=AS*(V(3)+DTH)                                                  AMAT      95
     C.....TRANSFORM VELOCITY TO COORDINATE OF ELEMENT AT WHICH IT IS INDUCED AMAT      96
        73 CONTINUE                                                            NOV09     55
           VI(1)=0.0                                                           AMAT      97
           VI(2)=0.0                                                           AMAT      98
           VI(3)=0.0                                                           AMAT      99
           DO 35 K=1,3                                                         AMAT     100
           DO 35 L=1,3                                                         AMAT     101
        35 VI(K)=VI(K)+V(L)*(EI(1,L)*E(1,K,I)+EI(2,L)*E(2,K,I)+EI(3,L)*        AMAT     102
          2E(3,K,I))                                                           AMAT     103
        71 CONTINUE                                                            AMAT     104
           BLK=-(-1.)**IZ                                                      AMAT     105
           A(I)=A(I)+VI(3)*BLK                                                 AMAT     106
           AY(I)=AY(I)+VI(2)*BLK                                               AMAT     107
           AX(I)=AX(I)+VI(1)*BLK                                               AMAT     108
           PHI(I)=PHI(I)+PH*BLK                                                AMAT     109
        45 CONTINUE                                                            AMAT     110
           XCPI(3)=-XCPI(3)                                                    AMAT     111
           DO 8 IU=1,4                                                         AMAT     112
         8 XTI(3,IU)=-XTI(3,IU)                                                AMAT     113
           EI(3,1)=-EI(3,1)                                                    AMAT     114
           EI(1,2)=-EI(1,2)                                                    AMAT     115
           EI(2,2)=-EI(2,2)                                                    AMAT     116
           EI(3,3)=-EI(3,3)                                                    AMAT     117
           DO 22 IU=1,3                                                        AMAT     118
           XBLAK=XTI(IU,2)                                                     AMAT     119
           XTI(IU,2)=XTI(IU,4)                                                 AMAT     120
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SUBROUTINE AMAT       73/73   OPT=1                    FTN 4.5+410       77/01/17. 11.07.10       PAGE     4

      22 XTI(IU,4)=XBLAK                                                  AMAT      121
       7 CONTINUE                                                         AMAT      122
         IF(IPHC)4,6                                                      NOV09      56
       4 CONTINUE                                                         NOV09      57
         XCPI(1)=-XCPI(1)                                                 AMAT.     123
         DO 9 IU=1,4                                                      AMAT      124
       9 XTI(1,IU)=-XTI(1,IU)                                             AMAT      125
         EI(1,1)=-EI(1,1)                                                 AMAT      126
         EI(2,2)=-EI(2,2)                                                 AMAT      127
         EI(3,2)=-EI(3,2)                                                 AMAT      128
         EI(1,3)=-EI(1,3)                                                 AMAT      129
         DO 23 IU=1,3                                                     AMAT      130
         XBLAK=XTI(IU,2)                                                  AMAT      131
         XTI(IU,2)=XTI(IU,4)                                              AMAT      132
      23 XTI(IU,4)=XBLAK                                                  AMAT      133
       6 CONTINUE                                                         AMAT      134
         WRITE(16)(A(K),K=1,IEM),(AX(K),K=1,IEM),(AY(K),K=1,IEM),         AMAT      135
        2(PHI(K),K=1,IEM)                                                 AMAT      136
       5 CONTINUE                                                         AMAT      137
         REWIND 16                                                        AMAT      138
         RETURN                                                           AMAT      139
         END                                                              AMAT      140
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SUBROUTINE OUTPUT      73/73    OPT=1                       FTN 4.5+410        77/01/17. 11.07.10        PAGE

      SUBROUTINE OUTPUT(IEM,IT,IN,ANG,SIG,VNO,AN,ANS,AX,AXS,                NOV03      58
     *AY,AYS,PHI,PHIS,PHIO,XC,XCP,IQ,IM,E,IPRINT,DDZ,HMAX,XCPB)             NOV03      59
      DIMENSION SIG(1),VNO(1),AX(1),PHIO(2,1),IO(1),IM(1),E(3,3,1),        OUTPUT      4
     *AY(1),XC(3,1),XCP(3,1),IT(4,1),IN(4,1),PHI(1),AN(1),ANS(1),AXS(1), OUTPUT      5
     *AYS(1),PHIS(1),XCPB(1)                                               OUTPUT      6
      IAC=0                                                                OUTPUT      7
      DO 15 I=1,IEM                                                        OUTPUT      8
      IF(IM(I).LT.2)IAC=IAC+1                                              OUTPUT      9
   15 AX(I)=AY(I)=PHI(I)=0.0                                               OUTPUT     10
      DO 20 I=1,IEM                                                        OUTPUT     11
      READ(16)(ANS(K),K=1,IEM),(AXS(K),K=1,IEM),(AYS(K),K=1,IEM),          OUTPUT     12
     *(PHIS(K),K=1,IEM)                                                    OUTPUT     13
      DO 20 J=1,IEM                                                        OUTPUT     14
      AX(J)=AX(J)+SIG(I)*AXS(J)                                            OUTPUT     15
      AY(J)=AY(J)+SIG(I)*AYS(J)                                            OUTPUT     16
   20 PHI(J)=PHI(J)+SIG(I)*PHIS(J)                                         OUTPUT     17
      REWIND 16                                                            OUTPUT     18
      IF(IPRINT.EQ.1)WRITE(6,2001)                                         OUTPUT     19
      WRITE(17)IAC,ANG,XCPB(1),XCPB(2),XCPB(3),DDZ,HMAX                    OUTPUT     20
      IM(IEM+1)=0                                                          OUTPUT     21
      C1=C2=C3=C4=C5=C6=C7=C8=0.0                                          DEC03       4
      DO 5 I=1,IEM                                                         OUTPUT     23
C.....DETERMINE AREA PROJECTION                                            OUTPUT     24
      XH1=E(1,3,I)                                                         OUTPUT     25
      XH2=E(2,3,I)                                                         OUTPUT     26
      XH3=E(3,3,I)                                                         OUTPUT     27
      ARA=PHIO(2,I)                                                        OUTPUT     28
      VX=AX(I)                                                             OUTPUT     29
      VY=AY(I)                                                             OUTPUT     30
      VZ=VNO(I)                                                            OUTPUT     31
      PH=PHI(I)                                                            OUTPUT     32
      V=SQRT(VX*VX+VY*VY+VZ*VZ)                                            OUTPUT     33
      VWX=E(1,1,I)*VX+E(1,2,I)*VY+E(1,3,I)*VZ                              OUTPUT     34
      VWY=E(2,1,I)*VX+E(2,2,I)*VY+E(2,3,I)*VZ                              OUTPUT     35
      VWZ=E(3,1,I)*VX+E(3,2,I)*VY+E(3,3,I)*VZ                              OUTPUT     36
      C1=PH*ARA+C1                                                         OUTPUT     37
      C2=VWX*ARA+C2                                                        OUTPUT     38
      C3=VWY*ARA+C3                                                        OUTPUT     39
      C4=VWZ*ARA+C4                                                        OUTPUT     40
      C5=XCP(1,I)*ARA+C5                                                   OUTPUT     41
      C6=XCP(2,I)*ARA+C6                                                   OUTPUT     42
      C7=XCP(3,I)*ARA+C7                                                   NOV05      13
      C8=C8+ARA                                                            OUTPUT     44
      IF(IM(I+1).EQ.2)GO TO 18                                             OUTPUT     45
      C1=C1/C8                                                             OUTPUT     46
      C2=C2/C8                                                             OUTPUT     47
      C3=C3/C8                                                             OUTPUT     48
      C4=C4/C8                                                             OUTPUT     49
      C5=C5/C8                                                             OUTPUT     50
      C6=C6/C8                                                             OUTPUT     51
      C7=C7/C8                                                             OUTPUT     52
      WRITE(17)IQ(I),IM(I),C1,C2,C3,C4,C5,C6,C7,XH1,XH2,XH3,C8             OUTPUT     53
      C1=C2=C3=C4=C5=C6=C7=C8=0.0                                          NOV08      19
   18 CONTINUE                                                             OUTPUT     55
      IF(IPRINT.EQ.0)GO TO 5                                               OUTPUT     56
      WRITE(6,2000)I,IQ(I),IM(I),XC(1,I),XCP(1,I),VWX,V,PH,SIG(I)          OUTPUT     57
      WRITE(6,2002)XC(2,I),XCP(2,I),VWY                                    OUTPUT     58
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SUBROUTINE OUTPUT      73/73    OPT=1                    FTN 4.5+410       77/01/17. 11.07.10       PAGE     2

            WRITE(6,2002)XC(3,I),XCP(3,I),VWZ                                      OUTPUT     59
          5 CONTINUE                                                               OUTPUT     60
            RETURN                                                                 OUTPUT     61
       2001 FORMAT(1H0,7HELEMENT,3X,7HREF NO.,3X,8HMOD CODE,5X,2HXC,9X,            NOV08      20
           23HXCP,7X,12HV COMPONENTS,10X,1HV,17X,3HPHI,15X,3HSIG)                  OUTPUT     63
       2000 FORMAT(1H0,3(I5,5X),2(2X,F8.4),5(F15.4,2X))                            OUTPUT     64
       2002 FORMAT(1H ,30X,2(2X,F8.4),F15.4)                                       OUTPUT     65
            END                                                                    OUTPUT     66

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

   19       I       XCPB       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
   19       I       XCPB       ARRAY REFERENCE OUTSIDE DIMENSION BOUNDS.
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SUBROUTINE PRESF       73/73    OPT=1                     FTN 4.5+410        77/01/17. 11.07.10        PAGE     1

      SUBROUTINE PRESF(ISTEP,IMODE,WX,VEZ,VEY,VEX,HMIN,CW,DT,ICON,CWT,    PRESF      2
     *CGL,NCW,D,VENTRY,IPHI,NNLD,FCF)                                      JAN10      9
      COMMON A(1),SIG(1)                                                   PRESF      4
      DIMENSION DT(1),IQ(3,1),IM(3,1),PH(3,1),VWX(3,1),VWY(3,1),VWZ(3,1)  NOV03     60
     *,XCP(3,3,1),XH(3,3,1),CW(1),AREA(3,1),FCP(2,1),RAD(1),IORD(1)        PRESF      6
      DIMENSION ANG(3),XCPB(3,3),DH(3),WX(1),VEZ(1),VEY(1),VEX(1),         PRESF      7
     *CWT(1),DSSS(1),HMAX(3),XC(2,1)                                       DEC01     48
C.....EQUIVALENCE SET UP FOR A MAXIMUM OF 300 ELEMENTS                     PRESF      9
C                     A(1),IQ(1)                                           PRESF     10
C                     A(3*NEL+1),IM(1)                                     PRESF     11
C                     A(6*NEL+1),PH(1)                                     PRESF     12
C                     A(9*NEL+1),VWX(1)                                    PRESF     13
C                     A(12*NEL+1),VWY(1)                                   PRESF     14
C                     A(15*NEL+1),VWZ(1)                                   PRESF     15
C                     A(18*NEL+1),XCP(1)                                   PRESF     16
C                     A(27*NEL+1),XH(1)                                    PRESF     17
C                     A(36*NEL+1),FCP(1)                                   PRESF     18
C                     A(38*NEL+1),AREA(1)                                  PRESF     19
C                     A(41*NEL+1),RAD(1)                                   PRESF     20
C                     A(42*NEL+1),IORD(1)                                  PRESF     21
C.....                A(45*NNEL+1),DSSS(1)                                 DEC01     49
C.....                REQUIRED STORAGE IN A IS 45*NDIM+NNEL                DEC01     50
      EQUIVALENCE(A(1),IQ(1)),(A(901),IM(1)),(A(1801),PH(1)),(A(2701),    PRESF     23
     *VWX(1)),(A(3601),VWY(1)),(A(4501),VWZ(1)),(A(5401),XCP (1)),         PRESF     24
     *(A(8101),XH(1)),(A(10801),FCP(1)),(A(11401),AREA(1))                 PRESF     25
     *,(A(12301),RAD(1)),(A(12601),IORD(1))                                PRESF     26
     *,(A(12901),XC(1)),(A(13501),DSSS(1))                                 DEC01     51
C.....SET INITIAL CONDITIONS                                               PRESF     28
      XPHI=3-IPHI                                                          NOV11     73
      SCALE=.7618*D*D*VENTRY*VENTRY                                        PRESF     29
      SCALED=SCALE*D                                                       PRESF     30
      H=0.0                                                                PRESF     31
      VENTRY2=VENTRY*VENTRY                                                PRESF     32
      DO 2 I=1,3                                                           PRESF     33
      ANG(I)=DH(I)=XCPB(I,3)=XCPB(I,2)=XCPB(I,1)=0.0                       PRESF     34
      DO 2 J=1,300                                                         PRESF     35
      IQ(I,J)=IM(I,J)=0                                                    PRESF     36
      PH(I,J)=VWX(I,J)=VWY(I,J)=VWZ(I,J)=0.0                               PRESF     37
      DSSS((I-1)*300+J)=0.0                                                PRESF     38
      DO 2 K=1,3                                                           NOV05     14
    2 XCP(K,I,J)=XH(K,I,J)=0.0                                             PRESF     39
      CONVR=57.29577951                                                    PRESF     40
      ISTEP=ISTEP-2                                                        PRESF     41
      READ(17)IEM,ANG(3),XCPB(3 ,1),XCPB(3,2),XCPB(3,3),DH(3),HMAX(3)      PRESF     42
      DO 5 I=1,IEM                                                         PRESF     43
      READ(17)IQ(3,I),IM(3,I),PH(3,I),VWX(3,I),VWY(3,I),VWZ(3,I)           PRESF     44
     *,(XCP(3,J,I),J=1,3),(XH(3,J,I),J=1,3),AREA(3,I)                      PRESF     45
    5 CONTINUE                                                             PRESF     46
      IF(ISTEP.GT.1)GO TO 6                                                DEC14     15
      IF(HMIN.LT.1.E-08 .AND.ISTEP.EQ.1)GO TO 6                            DEC14     16
      WRITE(6,2003)                                                        DEC14     17
 2003 FORMAT(*1 INSUFFICIENT NUMBER OF STEPS COMPLETED,PRESSURES CAN NOT  NOV05     17
     * BE CALCULATED.*)                                                    DEC14     18
      STOP                                                                 DEC14     19
    6 TSSS=T=0.0                                                           NOV05     19
      DO 40 I=1,ISTEP                                                      PRESF     48
      TSSS=TSSS+VENTRY*DT(I)/D                                             NOV08     21
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SUBROUTINE PRESF       73/73    OPT=1                        FTN 4.5+410       77/01/17. 11.07.10       PAGE    2

                   T=T+DT(I)                                                   PRESF      51
                   DO 13 J=1,2                                                 PRESF      52
                   DH(J)=DH(J+1)                                               PRESF      53
                   XCPB(J,1)=XCPB(J+1,1)                                       PRESF      54
                   XCPB(J,2)=XCPB(J+1,2)                                       PRESF      55
                   XCPB(J,3)=XCPB(J+1,3)                                       PRESF      56
                   ANG(J)=ANG(J+1)                                             PRESF      57
                   HMAX(J)=HMAX(J+1)                                           PRESF      58
                   DO 13 K=1,IEM                                               PRESF      60
                   IQ(J,K)=IQ(J+1,K)                                           PRESF      61
                   IM(J,K)=IM(J+1,K)                                           PRESF      62
                   PH(J,K)=PH(J+1,K)                                           PRESF      63
                   VWX(J,K)=VWX(J+1,K)                                         PRESF      64
                   VWY(J,K)=VWY(J+1,K)                                         PRESF      65
                   VWZ(J,K)=VWZ(J+1,K)                                         PRESF      66
                   AREA(J,K)=AREA(J+1,K)                                       PRESF      67
                   DO 13 L=1,3                                                 PRESF      68
                   XCP(J,L,K)=XCP(J+1,L,K)                                     PRESF      69
                13 XH(J,L,K)=XH(J+1,L,K)                                       PRESF      70
                   IEM2=IEM                                                    PRESF      71
                   READ(17)IEM,ANG(3),XCPB(3,1),XCPB(3,2),XCPB(3,3),DH(3),HMAX(3) PRESF   72
                   DO 15 J=1,IEM                                               PRESF      73
                   READ(17)IQ(3,J),IM(3,J),PH(3,J),VWX(3,J),VWY(3,J),VWZ(3,J)  PRESF      74
                  *,(XCP(3,K,J),K=1,3),(XH(3,K,J),K=1,3),AREA(3,J)             PRESF      75
                15 CONTINUE                                                    PRESF      76
                   COST=COS((90.-ANG(2))/CONVR)                                PRESF      77
                   SINT=SIN((90.-ANG(2))/CONVR)                                PRESF      78
                   IF(HMIN.GT.1.E-08.AND.I.EQ.1)GO TO 40                       PRESF      79
                   DO 25 J=1,IEM2                                              PRESF      80
                   IFAC=IQ(2,J)                                                PRESF      81
                   IPAS=IFUT=0                                                 PRESF      82
                   DO 30 K=1,IEM                                               PRESF      83
              C.....DETERMINE OPTION FOR PHI DOT                               PRESF      84
                   IF(IQ(1,K).EQ.IFAC)IPAS=K                                   PRESF      85
                   IF(IQ(3,K).EQ.IFAC)IFUT=K                                   PRESF      86
                30 CONTINUE                                                    PRESF      87
                   IF(IPAS.EQ.0)GO TO 71                                       PRESF      88
                   IF(IM(1,IPAS).EQ.0)GO TO 72                                 PRESF      89
                   IF(IM(2,J).EQ.0)GO TO 74                                    PRESF      90
                71 DH1=PH1=0.0                                                 PRESF      91
                   IF(IMODE.EQ.0)GO TO 73                                      PRESF      92
                   IF(IPAS.EQ.0)GO TO 73                                       PRESF      93
                74 DH1=XCP(1,3,IPAS)                                           PRESF      94
                   PH1=PH(1,IPAS)                                              PRESF      95
                   GO TO 73                                                    PRESF      96
                72 DH1=XCP(1,3,IPAS)                                           PRESF      97
                   PH1=PH(1,IPAS)                                              PRESF      98
                73 DH3=XCP(3,3,IFUT)                                           PRESF      99
                   PH3=PH(3,IFUT)                                              PRESF     100
              C.....CALCULATE PHI DOT                                          PRESF     102
                   RZ=XCP(2,3,J)-XCPB(2,3)                                     NOV03      61
                   RY=XCP(2,2,J)-XCPB(2,2)                                     NOV03      62
                   D1=WX(I)*DT(I)/CONVR                                        NOV08      22
                   D2=WX(I+1)*DT(I+1)/CONVR                                    NOV08      23
                   VZP=VEZ(I)+(RZ*(1.-COS(D1))+RY*SIN(D1))/DT(I)               NOV05      23
                   VZF=VEZ(I+1)-(RZ*(1.-COS(D2))-RY*SIN(D2))/DT(I+1)           NOV05      24
                   CWP=(VZP*DT(I)-DH(2))/(VZP*DT(I))                           NOV07       1
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      CWF=(VZF*DT(I+1)-DH(3))/(VZF*DT(I+1))                           NOV05      26
      DELT1=(XCP(2,3,J)-DH1)/(CWP*VZP)                                PRESF     107
      DELT2=(DH3-XCP(2,3,J))/(CWF*VZF)                                NOV05      29
      DPH1=(PH(2,J)-PH1)/DELT1                                        NOV05      30
      DPH2=(PH3-PH(2,J))/DELT2                                        NOV05      31
      DPH=DPH1+(DPH2-DPH1)*DELT1/(DELT1+DELT2)                        NOV08      24
      V2=VWX(2,J)**2+VWY(2,J)**2+VWZ(2,J)**2                          NOV05      33
      FCP(1,J)=2.*DPH/VENTRY2                                         PRESF     113
      IF(ICON.EQ.0)FCP(1,J)=FCP(1,J)/CWT(I)                           NOV06       1
      DOTX=VEX(I)+VEX(I+1)                                            JAN10      10
      DOTY=VEY(I)+VEY(I+1)-(WX(I)+WX(I+1))*RZ/CONVR                   JAN10      11
      DOTZ=VEZ(I)+VEZ(I+1)+(WX(I)+WX(I+1))*RY/CONVR                   JAN10      12
      FCP(2,J)=(DOTX*VWX(2,J)+DOTY*VWY(2,J)+DOTZ*VWZ(2,J)-V2)/VENTRY2 JAN10      13
      IF(IM(2,J).NE.1)GO TO 60                                        DEC27      27
      FCP(1,J)=FCP(1,J)*FCF                                           DEC27      28
      FCP(2,J)=FCP(2,J)*FCF                                           DEC27      29
   60 CONTINUE                                                        DEC15       7
      IF(IM(2,J).NE.0)DSSS(IQ(2,J))=0.0                               NOV08      26
      DSSS(IQ(2,J))=DSSS(IQ(2,J))+DELT1                               NOV08      27
C.....TRANSFORM COORDINATES                                            PRESF     118
      XC(2,J)=SINT*RY+COST*RZ+ CGL                                    PRESF     121
      XC(1,J)=COST*RY-SINT*RZ                                         PRESF     122
   25 CONTINUE                                                        PRESF     123
      DO 50 JI=1,NCW                                                  PRESF     124
      FX=FY=FZ=SMX=SMY=SMZ=0.0                                        DEC14      20
      IFLAG=0                                                         DEC27      30
      IF(ICON.EQ.1)GO TO 83                                           NOV02       5
C.....CONSTANT ORIENTATION OUTPUT                                      PRESF     127
      VDOWN=VENTRY*COST*CW(JI)                                        PRESF     128
      H=HMAX(2)                                                       PRESF     129
      T=H/VDOWN                                                       PRESF     130
      TSAR=VENTRY*T/D                                                 PRESF     131
      WRITE(6,2005)I,H,T,TSAR,CW(JI)                                  PRESF     132
      WRITE(6,2000)                                                   PRESF     133
      DO 51 KI=1,IEM2                                                 PRESF     134
      IF(IQ(2,KI).LT.NNLD.OR.IFLAG.EQ.1)GO TO 75                      DEC27      31
      IFLAG=1                                                         DEC27      32
      WRITE(6,2012)                                                   DEC27      33
   75 CONTINUE                                                        DEC27      34
      CP=FCP(1,KI)*CW(JI)+FCP(2,KI)                                   PRESF     135
      IF(IQ(2,KI).LT.NNLD.AND.CP.LT.0)CP=0.0                          DEC27      35
      PRES=CP*.97*VENTRY2                                             PRESF     137
      IF(IQ(2,KI).GE.NNLD)PRES=0.0                                    DEC15      [illegible]
      TES=-XCP(2,3,KI)*VENTRY/(VDOWN*D)                               PRESF     138
      FORCET=PRES*AREA(2,KI)                                          PRESF     [illegible]
      WRITE(6,2001)KI,IQ(2,KI),IM(2,KI),AREA(2,KI),XCP(2,1,KI)        PRESF     [illegible]
     *,XC(1,KI),XC(2,KI),TES,CP,PRES,FORCET                            NOV08      28
      F1=-XM(2,1,KI)*FORCET                                           DEC14      22
      F2=-XM(2,2,KI)*FORCET*XPHI                                      NOV11      74
      F3=-XM(2,3,KI)*FORCET*XPHI                                      NOV11      75
      FX=FX+F1                                                        DEC14      23
      FY=FY+F2                                                        PRESF     144
      FZ=FZ+F3                                                        PRESF     145
      RAX=XCP(2,1,KI)-XCPB(2,1)                                       DEC14      24
      RAY=XCP(2,2,KI)-XCPB(2,2)                                       DEC14      25
      RAZ=XCP(2,3,KI)-XCPB(2,3)                                       DEC14      26
      SMX=SMX+RAY*F3-RAZ*F2                                           DEC14      27
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SUBROUTINE PRESF      73/73   OPT=1                          FTN 4.5+410         77/01/17. 11.07.10        PAGE     4

            SMY=SMY-RAX*F3+RAZ*F1                                                  DEC14      28
            SMZ=SMZ+RAX*F2-F1*RAY                                                  DEC14      29
         51 CONTINUE                                                               PRESF     147
            GO TO 81                                                               PRESF     148
         83 CONTINUE                                                               NOV02       6
      C.....VARIABLE ORIENTATION OUTPUT                                            PRESF     150
            WRITE(6,2006)I,HMAX(2),T,TSSS,CWT(I),CWT(I+1)                          PRESF     151
            WRITE(6,2007)(VEX(I+1)+VEX(I))/2.,(VEY(I+1)+VEY(I))/2.,                PRESF     152
           1(VEZ(I+1)+VEZ(I))/2.,(WX(I+1)+WX(I))/2.,ANG(2)                         NOV08      31
            WRITE(6,2000)                                                          PRESF     154
            DO 82 KI=1,IEM2                                                        PRESF     155
            IF(IO(2,KI).LT.NNLD.OR.IFLAG.EQ.1)GO TO 76                             DEC27      36
            IFLAG=1                                                                DEC27      37
            WRITE(6,2012)                                                          DEC27      38
         76 CONTINUE                                                               DEC27      39
            CP=FCP(1,KI)+FCP(2,KI)                                                 PRESF     156
            IF(IO(2,KI).LT.NNLD.AND.CP.LT.0)CP=0.0                                 DEC27      40
            PRES=CP*.97*VENTRY2                                                    PRESF     158
            IF(IO(2,KI).GE.NNLD)PRES=0.0                                           DEC15      13
            FORCET=PRES*AREA(2,KI)                                                 PRESF     159
            TES=DSSS(IO(2,KI))*VENTRY/D                                            NOV08      32
            WRITE(6,2001)KI,IO(2,KI),IM(2,KI),AREA(2,KI),XCP(2,1,KI),XC(1,KI)      NOV08      33
           1,XC(2,KI),TES,CP,PRES,FORCET                                           NOV08      34
            F1=-XH(2,1,KI)*FORCET                                                  DEC14      31
            F2=-XH(2,2,KI)*FORCET*XPHI                                             NOV11      76
            F3=-XH(2,3,KI)*FORCET*XPHI                                             NOV11      77
            FX=FX+F1                                                               DEC14      32
            FY=FY+F2                                                               PRESF     164
            FZ=FZ+F3                                                               PRESF     165
            RAX=XCP(2,1,KI)-XCPB(2,1)                                              DEC14      33
            RAY=XCP(2,2,KI)-XCPB(2,2)                                              DEC14      34
            RAZ=XCP(2,3,KI)-XCPB(2,3)                                              DEC14      35
            SMX=SMX+RAY*F3-RAZ*F2                                                  DEC14      36
            SMY=SMY-RAX*F3+RAZ*F1                                                  DEC14      37
            SMZ=SMZ+RAX*F2-F1*RAY                                                  DEC14      38
         82 CONTINUE                                                               PRESF     167
         81 CONTINUE                                                               PRESF     168
            IF(IPHI.EQ.1)FX=SMY=SMZ=0.0                                            DEC14      39
            FN= FZ*SINT-FY*COST                                                    PRESF     169
            FD=(FZ*COST+SINT*FY)                                                   PRESF     170
            WRITE(6,2002)FX,FD,FN,SMX,SMY,SMZ                                      DEC14      40
            CX=FX/SCALE                                                            DEC14      41
            CN=FN/SCALE                                                            PRESF     172
            CD=FD/SCALE                                                            PRESF     173
            CMX=SMX/SCALED                                                         DEC14      42
            CMY=SMY/SCALED                                                         DEC14      43
            CMZ=SMZ/SCALED                                                         DEC14      44
            WRITE(6,2011)CX,CD,CN,CMX,CMY,CMZ                                      DEC14      45
         50 CONTINUE                                                               PRESF     176
         40 CONTINUE                                                               PRESF     177
            RETURN                                                                 PRESF     179
       2000 FORMAT(1H0,1X,3HNO.,3X,7HREF.NO.,2X,3HMOD,5X,4HAREA,8X,1HX,9X,1HY,     PRESF     180
           *9X,1HZ,12X,2HT*,7X,2HCP,10X,1HP,9X,5HFORCE)                            PRESF     181
       2001 FORMAT(1H ,3(I4,2X),E12.4,3X,3(F9.6,1X),2X,F7.4,3X,F7.2,3X,            PRESF     182
           * 2(F12.4,1X))                                                          PRESF     183
       2002 FORMAT(1H0,5HFX = ,E15.7,2X,5HFD = ,E15.7,2X,5HFN = ,E15.7,            JAN10      14
           *2X, 6HSMX = ,E15.7,2X,6HSMY = ,E15.7,2X,6HSMZ = ,E15.7)                JAN10      15
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SUBROUTINE PRESF       73/73    OPT=1                          FTN 4.5+410       77/01/17. 11.07.10        PAGE

         2035 FORMAT(1H0,7X,5HSTEP ,I5,3X,8HDEPTH = ,F10.7,3X,7HTIME = ,F10.7,    DEC27       41
             *3X,19HDIMENSIONLESS TIME ,F10.7,3X,17HWETTING FACTOR = ,F10.7)      PRESF      186
         2006 FORMAT(1H0/1H0,7X,5HSTEP ,I5,3X,8HDEPTH = ,F10.7,3X,7HTIME = ,      PRESF      187
             *F10.7,3X,19HDIMENSIONLESS TIME ,F10.7,3X,18HWETTING FACTORS = ,     PRESF      188
             *2F10.7)                                                             PRESF      189
         2007 FORMAT(1H ,15X,*AVERAGE VELOCITY *,3(F10.3,2X) ,* WX *,F10.2,       NOV08       36
             **ORIENTATION *,F10.3)                                               NOV08       37
         2011 FORMAT(1H ,5HCX = ,F15.7,2X, 5HCD = ,F15.7,2X, 5HCN = ,F15.7,       DEC14       48
             *2X,6HMX =  ,F15.7,2X,6HMY =  ,F15.7,2X,6HMZ =  ,F15.7)              DEC14       49
         2012 FORMAT(1H0,30X,*NO LOAD ELEMENTS*)                                  DEC15       14
              END                                                                 PRESF      193

CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
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    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
    29      I         A       DIMENSIONAL RANGE IS EXTENDED FOR EQUIVALENCING PURPOSES.
```

```
SUBROUTINE SUAS        73/73    OPT=1                        FTN 4.5+410      77/01/17. 11.07.10     PAGE    1

         SUBROUTINE SUAS(IEM,IAVS ,NBLK,A,IP,VNO,SIG,STOR)             JAN01      7
C.....THIS SUBROUTINE SETS UP BLOCKS AND CALLS DECOMP AND SOLVE        DEC01     54
         DIMENSION A(1),SIG(1),IP(1),VNO(1),STOR(1)                    DEC03      5
C.....TRANSFER NORMAL VELOCITY                                         DEC01     56
         DO 5 K=1,IEM                                                  DEC01     57
         IP(K)=K                                                       DEC22      1
       5 SIG(K)=VNO(K)                                                 DEC01     58
         IF(IEM.GT.NBLK)GO TO 15                                       DEC27     43
C.....BLOCKS ARE NOT NECESSARY                                         DEC01     60
         DO 66 J=1,IEM                                                 DEC01     61
         READ(16)(A((I-1)*IEM+J),I=1,IEM)                              DEC03      6
      66 CONTINUE                                                      DEC01     63
         REWIND 16                                                     DEC01     64
         IEM2=IEM*IEM                                                  DEC03      7
         CALL WRITMS(3,A,IEM2,1)                                       DEC03      8
         NR=IEM                                                        DEC01     66
         GO TO 50                                                      DEC01     67
C.....BLOCKS ARE NEEDED                                                DEC01     68
      15 NMAX=IAVS/IEM                                                 JAN01      8
         NUM=IEM/NMAX                                                  JAN01      9
         IF(NUM*NMAX.NE.IEM)NUM=NUM+1                                  DEC01     70
C.....CONSTRUCT BLOCKS                                                 DEC01     71
         NR=NMAX                                                       DEC01     72
         DO 10 I=1,NUM                                                 DEC01     73
         NB=1+(I-1)*NMAX                                               DEC01     74
         NU=I*NMAX                                                     DEC01     75
         IF(I.EQ.NUM)NU=IEM                                            DEC01     76
         DO 20 K=1,IEM                                                 DEC01     77
         READ(16)(STOR(L),L=1,IEM)                                     DEC01     78
         IC=-1                                                         DEC12      6
         DO 20 J=NB,NU                                                 DEC03      9
         IC=IC+1                                                       DEC12      7
         IBL=IC*IEM+K                                                  DEC12      8
         A(IBL)=STOR(J)                                                DEC12      9
      20 CONTINUE                                                      DEC12     10
         NRT=(NU-NB+1)*IEM                                             DEC03     11
         CALL WRITMS(3,A,NRT,I)                                        DEC01     84
         REWIND 16                                                     DEC01     85
      10 CONTINUE                                                      DEC01     86
      50 CONTINUE                                                      DEC01     87
C.....SOLVE                                                            DEC01     88
         CALL DDECOMP(IEM,NR,A,IP)                                     DEC01     89
         IF(IP(IEM).NE.0)GO TO 51                                      DEC01     90
         WRITE(6,2000)                                                 DEC01     91
    2000 FORMAT(1H1,30X,*SINGULAR MATRIX*)                             DEC01     92
         STOP                                                          DEC01     93
      51 CONTINUE                                                      DEC01     94
         CALL DSOLVE(IEM,NR,A,SIG,IP)                                  DEC01     95
         RETURN                                                        DEC01     96
         END                                                           DEC01     97
```

SUBROUTINE DDECOMP   73/73   OPT=1   FTN 4.5+410   77/01/17. 11.07.10   PAGE   1

```
      SUBROUTINE DDECOMP(N,NR,R,IP)                        DEC01      98
      DIMENSION R(1),IP(1)                                 DEC01      99
      INTEGER RSUBKN,RSTUB                                 DEC01     100
      DATA EPS/1.0E-10/                                    DEC01     101
      NM1=N-1                                              DEC01     102
      NEL=N*NR                                             DEC01     103
      IP(N)=N                                              DEC01     104
      NBLOCK=N/NR                                          DEC01     105
      NP=NBLOCK*NR                                         DEC01     106
      IF(NP.LT.N)NBLOCK=NBLOCK+1                           DEC01     107
      NBNEL=NEL+NEL                                        DEC01     108
      IDX1=1                                               DEC01     109
      RSUBKN=-N                                            DEC01     110
      CALL READMS( 3,R,NEL,IDX1)                           DEC01     111
      IDX1=IDX1+1                                          DEC01     112
      DO 6 K=1,NM1                                         DEC01     113
      RSUBKN=RSUBKN+N                                      DEC01     114
      IF(RSUBKN.NE.NEL)GO TO 30                            DEC01     115
      IF(IDX1.GT.NBLOCK)GO TO 30                           DEC01     116
      CALL WRITMS(3,R,NEL,IDX1-1)                          DEC01     117
      CALL READMS(3,R,NEL,IDX1)                            DEC01     118
      IDX1=IDX1+1                                          DEC01     119
      RSUBKN=0                                             DEC01     120
   30 CONTINUE                                             DEC01     121
      KP1=K+1 $ KLOW=RSUBKN+KP1 $ KHIGH=RSUBKN+N           DEC01     122
      M=KK=K+RSUBKN                                        DEC01     123
      RM=R(M)                                              DEC22       2
      DO 1 I=KLOW,KHIGH                                    DEC01     124
      IF(ABS(R(I)).LE.ABS(RM))GO TO 1                      DEC22       3
      RM=R(I)                                              DEC22       4
      M=I                                                  DEC22       5
    1 CONTINUE                                             DEC01     126
      T=-R(M)                                              DEC01     127
      IF(ABS(T).LE.EPS)GO TO 7                             DEC01     128
      MK=M-RSUBKN                                          DEC22       6
      KSAVE=IP(K)                                          DEC22       7
      IP(K)=IP(MK;                                         DEC22       8
      IP(MK)=KSAVE                                         DEC22       9
      R(M)=R(KK)                                           DEC01     131
      R(KK)=-T                                             DEC01     132
   12 IDX2=IDX1                                            DEC01     133
      IF(IDX1.GT.NBLOCK)GO TO 40                           DEC01     134
      CALL READMS(3,R(NEL+1),NEL,IDX2)                     DEC01     135
      IDX2=IDX2+1                                          DEC01     136
   40 CONTINUE                                             DEC01     137
      RSTUB=RSUBKN                                         DEC01     138
      IFLAG=0                                              DEC22      10
      DO 2 I=KP1,N                                         DEC01     139
      RSTUB=RSTUB+N                                        DEC01     140
      IF(RSTUB.LT.NBNEL)GO TO 50                           DEC01     141
      CALL WRITMS(3,R(NEL+1),NEL,IDX2-1)                   DEC01     142
      CALL READMS(3,R(NEL+1),NEL,IDX2)                     DEC01     143
      IDX2=IDX2+1                                          DEC01     144
      RSTUB=NEL                                            DEC01     145
   50 CONTINUE                                             DEC01     146
      T1=R(RSTUB+MK)                                       DEC01     147
      IF(MK.EQ.K)GO TO 11                                  DEC01     148
```

```
SUBROUTINE DDECOMP    73/73    OPT=1                  FTN 4.5+410      77/01/17. 11.07.10      PAGE    2

         IF(IFLAG.EQ.1)GO TO 68                                             DEC22      11
         IFLAG=1                                                            DEC22      12
         ISTUB=1                                                            DEC22      13
      61 IF(ISTUB.EQ.IDX1-1)GO TO 69                                        DEC22      14
         CALL READMS(3,R(NEL+1),NEL,ISTUB)                                  DEC22      15
         KSTUB=NEL                                                          DEC22      16
         DO 62 KK=1,NR                                                      DEC22      17
         T2=R(KSTUB+MK)                                                     DEC22      18
         R(KSTUB+MK)=R(KSTUB+K)                                             DEC22      19
         R(KSTUB+K)=T2                                                      DEC22      20
         KSTUB=KSTUB+N                                                      DEC22      21
      62 CONTINUE                                                           DEC22      22
         CALL WRITMS(3,R(NEL+1),NEL,ISTUB)                                  DEC22      23
         ISTUB=ISTUB+1                                                      DEC22      24
         GO TO 61                                                           DEC22      25
      69 IF(IDX1.GT.NBLOCK)GO TO 63                                         DEC22      26
         CALL READMS(3,R(NEL+1),NEL,IDX2-1)                                 DEC22      27
      63 CONTINUE                                                           DEC22      28
         KSUBKN=0                                                           DEC22      29
      64 CONTINUE                                                           DEC22      30
         IF(KSUBKN.EQ.RSUBKN)GO TO 68                                       DEC22      31
         T2=R(KSUBKN+MK)                                                    DEC22      32
         R(KSUBKN+MK)=R(KSUBKN+K)                                           DEC22      33
         R(KSUBKN+K)=T2                                                     DEC22      34
         KSUBKN=KSUBKN+N                                                    DEC22      35
         GO TO 64                                                           DEC22      36
      68 CONTINUE                                                           DEC22      37
         R(RSTUB+MK)=R(RSTUB+K)                                             DEC01     149
      11 R(RSTUB+K)=T1/T                                                    DEC01     150
         DO 2 J=KP1,N                                                       DEC01     151
       2 R(RSTUB+J)=R(RSTUB+J)+R(RSTUB+K)*R(RSUBKN+J)                       DEC01     152
         IF(NBLOCK.EQ.1)GO TO 6                                             DEC12      11
         CALL WRITMS(3,R(NEL+1),NEL,NBLOCK)                                 DEC01     153
       6 CONTINUE                                                           DEC01     154
         CALL WRITMS(3,R,NEL,IDX1-1)                                        DEC01     155
         IF(P(RSUBKN+N+N).GT.EPS)RETURN                                     DEC01     156
       7 IP(N)=0                                                            DEC01     157
         RETURN                                                             DEC01     158
         END                                                                DEC01     159
```

SUBROUTINE DSOLVE 73/73 OPT=1 FTN 4.5+410 77/01/17. 11.07.10 PAGE 1

```
      SUBROUTINE DSOLVE(N,NR,R,B,IP)                           DEC01   160
      DIMENSION R(1),B(1),IP(1)                                DEC01   161
      INTEGER RSUBKN                                           DEC01   162
      NM1=N-1                                                  DEC01   163
      NEL=N*NR                                                 DEC01   164
      NBLOCK=N/NR                                              DEC01   165
      NP=NBLOCK*NR                                             DEC01   166
      IF(NP.LT.N)NBLOCK=NBLOCK+1                               DEC01   167
      IDX=1                                                    DEC01   168
      RSUBKN=0                                                 DEC01   169
      CALL READMS(3,R,NEL,IDX)                                 DEC01   170
      IDX=IDX+1                                                DEC01   171
      DO 200 I=2,N                                             DEC01   172
      RSUBKN=RSUBKN+N                                          DEC01   173
      IF(RSUBKN.NE.NEL)GO TO 30                                DEC01   174
      RSUBKN=0                                                 DEC01   175
      CALL READMS(3,R,NEL,IDX)                                 DEC01   176
      IDX=IDX+1                                                DEC01   177
   30 CONTINUE                                                 DEC01   178
      YI=B(I)                                                  DEC01   179
      IM1=I-1                                                  DEC01   180
      DO 220 J=1,IM1                                           DEC01   181
      YI=YI+R(RSUBKN+J)*B(J)                                   DEC01   182
  220 CONTINUE                                                 DEC01   183
      B(I)=YI                                                  DEC01   184
  200 CONTINUE                                                 DEC01   185
      IDX=NBLOCK                                               DEC01   186
      B(N)=B(N)/R(RSUBKN +N)                                   DEC01   187
      DO 230 II=1,NM1                                          DEC01   188
      I=N-II                                                   DEC01   189
      RSUBKN=RSUBKN-N                                          DEC01   190
      IF(RSUBKN.LT.0)221,225                                   DEC01   191
  221 IDX=IDX-1                                                DEC01   192
      CALL READMS(3,R,NEL,IDX)                                 DEC01   193
      RSUBKN=NEL-N                                             DEC01   194
  225 CONTINUE                                                 DEC01   195
      XI=B(I)                                                  DEC01   196
      IP1=I+1                                                  DEC01   197
      DO 260 J=IP1,N                                           DEC01   198
      XI=XI-R(RSUBKN+J)*B(J)                                   DEC01   199
  260 CONTINUE                                                 DEC01   200
      B(I)=XI/R(RSUBKN+I)                                      DEC01   201
  230 CONTINUE                                                 DEC01   202
      DO 300 K=1,N                                             DEC01   203
      M=IP(K)                                                  DEC01   204
      R(M)=B(K)                                                DEC01   205
  300 CONTINUE                                                 DEC01   206
      DO 301 K=1,N                                             DEC01   207
  301 B(K)=R(K)                                                DEC01   208
      RETURN                                                   DEC01   209
      END                                                      MATRIX   88
```

SUBROUTINE CENT 73/73 OPT=1 FTN 4.5+410 77/01/17. 11.07.10 PAGE

```
      SUBROUTINE CENT(X,XC,IS,IEM,AREA)                                CENT      2
      DIMENSION X(3,1),XC(3,1),IS(4,1),AREA(2,1),XTT(3,2),THETA(2)     NOV02     7
      DO 10 K=1,IEM                                                    CENT      4
      I1=IS(1,K)                                                       CENT      5
      I2=IS(2,K)                                                       CENT      6
      I3=IS(3,K)                                                       CENT      7
      I4=IS(4,K)                                                       CENT      8
C.....CALCULATE AREAS                                                  CENT      9
      A1=A2=B1=B2=C=0.0                                                CENT     10
      DO 44 I=1,3                                                      CENT     11
      A1=A1+(X(I,I2)-X(I,I1))**2                                       CENT     12
      B1=B1+(X(I,I3)-X(I,I2))**2                                       CENT     13
      C=C+(X(I,I3)-X(I,I1))**2                                         CENT     14
      A2=A2+(X(I,I4)-X(I,I1))**2                                       CENT     15
   44 B2=B2+(X(I,I3)-X(I,I4))**2                                       CENT     16
      DHD=(A1+B1-C)/2./SQRT(A1*B1)                                     CENT     17
      EHE=(A2+B2-C)/2./SQRT(A2*B2)                                     CENT     18
      IF(DHD.GT.1.)DHD=1.                                              CENT     19
      IF(DHD.LT.-1.)DHD=-1.                                            CENT     20
      IF(EHE.GT.1.)EHE=1.                                              CENT     21
      IF(EHE.LT.-1.)EHE=-1.                                            CENT     22
      THETA(1)=ACOS(DHD)                                               CENT     23
      THETA(2)=ACOS(EHE)                                               CENT     24
      AREA1=.5*SQRT(A1*B1)*SIN(THETA(1))                               CENT     25
      AREA2=.5*SQRT(A2*B2)*SIN(THETA(2))                               CENT     26
      AREA(2,K)=AREAT=AREA1+AREA2                                      CENT     27
C.....CALCULATE CENTROIDE IN BODY COORDINATES                          CENT     28
      DO 60 L=1,3                                                      CENT     29
      XTT(L,1)=(X(L,I1)+X(L,I2)+X(L,I3))/3.                            CENT     30
      XTT(L,2)=(X(L,I1)+X(L,I3)+X(L,I4))/3.                            CENT     31
   60 CONTINUE                                                         CENT     32
      DO 70 L=1,3                                                      CENT     33
   70 XC(L,K)=(AREA1*XTT(L,1)+AREA2*XTT(L,2))/AREAT                    CENT     34
   10 CONTINUE                                                         CENT     35
      RETURN                                                           CENT     36
      END                                                              CENT     37
```

APPENDIX C

USER INSTRUCTIONS AND SAMPLE RUNS

The current version of the code can be applied to arbitrary bodies. It was developed on a CDC 6500 and requires about 105K storage octal. The grid describing the entry body may contain up to 750 nodes* and 500 elements, however, execution will terminate when more than 300 of these elements become submerged. This appendix described the available program options, necessary input cards and output format. Sample runs are provided to illustrate the use of this program.

Program Options and Required Input

Program input can be divided into three parts. In the first, the basic program options are specified:

Card No.	Variable	Format
1	CONSTANT or VARIABLE body orientation	2A4
2	PRINT or DON'T PRINT	3A4
3	ASYMMETRIC or SYMMETRIC mode	3A4

Under the CONSTANT body orientation option the entry model is assumed to retain its initial orientation and velocity throughout the entry process. As discussed previously, the natural problem variable in this case is depth rather than time. With little increase in computational time, pressures and forces can be evaluated for a number of different wetting factors, C_w. The VARIABLE body orientation option allows the velocity, orientation, wetting factor and time increments between steps to be varied. The only restriction is that the angular velocity of the body must be small enough to insure that the depth of the body increases monotonically in time. The maximum number of steps is limited to 49.

The PRINT option is used to obtain flow field and element information at each step of the calculation. It is applied only for diagnostic purposes. The second option, DON'T PRINT, is recommended and produces only grid information and the final pressures and forces on the model.

If the SYMMETRIC mode option is used, the entry model is assumed to possess planar symmetry about the y-z plane. The ASYMMETRIC option does not assume any symmetry and hence can be applied to arbitrary bodies. This mode is also used on symmetric bodies where V_x is none-zero.

---

*Storage is set up for 800 nodes. However, this must also include room for nodes generated at each step.

The second set of input cards describes the entry conditions and the required information differs depending on whether the CONSTANT or VARIABLE body orientation option is used. For the CONSTANT option the following data cards are required:

Card No.	Variables	Format
4	IMAX, D, VENTRY, ANG, SUMT, HMIN, DH, ALPHA	I5, 5X, 7F10.0
5	CGL, FCF, ANGB, NNLD	3F10.0, I5
6	NCW, CW(1), CW(2)........(CW(NCW)	I5, 5X, 7F10.0/ (8F10.0)
7	omit	

These variables are defined as follows:

IMAX — Number of steps at which pressures and loads are calculated. The present calculative procedure inserts the model into the water in a series of steps, each at a greater depth than the preceding one. When the step count becomes greater than IMAX execution is terminated

D — Diameter (in feet). This quantity is only used for calculating force coefficients

VENTRY — Entry velocity in ft/sec

ANG — Orientation of the model (in degrees) relative to the water surface (see Fig. C-1)

SUMT — Program time limit. This must correspond to the time limit on the job card

HMIN — Initial body depth (i.e., measured from the lowest point on the body). This parameter is zero if the loads are calculated from time of initial wetting. Note that if this variable is not zero pressures and forces are first calculated at HMIN + 2DH. This parameter allows pressures and forces at a particular depth to be determined without calculating the entire force-time history from initial wetting.

DH — Increment in depth in feet between successive steps. It is necessary to coordinate this variable with the specified model grid which is defined on the last set of data cards. The following apply to determining DH:

a. OBLIQUE ENTRY WITH STANDARD GRID OPTION. DH should be picked so that the average element is submerged in two steps. On models of complex shape this criteria can only be satisfied in the mean and primary consideration should be given to the portion of the body which experiences the greatest load. Generally this will be on elements whose plane is perpendicular to the direction of motion.

b. VERTICAL ENTRY WITH STANDARD GRID OPTION OR OBLIQUE ENTRY WITH THE OGIVE OPTION. For vertical entry or if the OGIVE grid option is used, elements will have a pair of side parallel to the water surface. In this case it is important to choose the step size very precisely so that each element will be submerged in exactly two steps. To insure that the top row of elements is included in an unmodified state in the code and that the next row of elements is excluded, the actual water surface should fall a small distance ε above the upper edge of the top row of element to be included as shown in Figure C-2. Here $0 < \varepsilon < \Delta h$ where Δh is defined by

$$\Delta h = \frac{\sqrt{\text{average element area}}}{1000}$$

ALPHA — Angle of attack in degrees (see Fig. C-1)

CGL — z' coordinate of the center of gravity (see Fig. C-1)

FCF — Pressure correction factor on elements with a modification code of 1. For the oblique entry of blunt bodies (nose length/diameter < 1) set to unit. For other cases use a value of .67.

ANGB — Yaw angle in degrees of $\overline{V}_I$. Velocity components in the x,y,z direction are $V_I$sin (ANGB), $-V_I$cos(ANG)cos(ANG + ALPHA) and $- V_I$cos(ANG) sin(ANG + ALPHA)

NNLD — Number of wetting factors to be used. Since the most appropriate value may not be clear, for little extra computational cost pressure and loads may be calculated for several different wetting factor values

CW — Wetting Factor. This parameter describes the rate of surface rise and is equal to the ratio of h/h' defined in Figure 1. For best results, the test cases reported on should be used as a guide. An approximate rule for determining this parameter is as follows:

(1) POINTED BODIES (ALSO INCLUDES SLIGHTLY BLUNTED ONES). Determine the angle, θ_c, between the tangent to the body surface and the body axis at both the nosetip and base of the nose. At the nose neglect any effect due to body blunting. Insert the two resulting values of θ_c in radians into:

$$C_w = \frac{1}{[1 - .396\theta_c + .287\theta_c^{\,2} - .124\theta_c^{\,3}]} \qquad \text{(C-1)}$$

Average the two calculated values of C_w to obtain the final one to be used in the code. If ALPHA is non-zero increment θ_c by ALPHA

(2) FLAT PLATES. Use a value of 1.45 for ANG > 45 degrees and 1.55 for ANG < 45.

(3) SPHERICAL BODIES. Use a value of 1.55 for near vertical entry and 1.35 for oblique entry.

The classification of an arbitrary body into one of the above categories is a matter of experience. On complex shapes classification should be based on the portion of the body sustaining the majority of the impact loading.

If the VARIABLE body orientation option is used the following data cards are required:

Card No.	Variables	Format
4	IMAX, D, VENTRY, ANG, SUMT, HMIN	15, 5X, 7F10.0
5	CGL, FCF, NNLD	2F10.0, 10X, 15
6	NVP	
7.1	VX(1), VY(1), VZ(1), CW(1), DH(1)	6F10.0
.		
.		
7.NVP	VX(NVP), VY(NVP), VZ(NVP), WX(NVP), CW(NVP), DH(NVP)	6F10.0

The variables on cards 4 and 5 are defined above. In this case, VENTRY is only used in determining the force and pressure coefficients and ANG is the initial body orientation. The body velocity, wetting factor, and increment in depth for each step is defined in cards 7.

NVP	Number of different steps at which entry conditions are specified
VX(I), VY(I), VZ(I)	Velocity components in the x,y,z directions of the center of gravity in ft/sec applied between steps I-1, and I
WX(I)	Angular velocity in degrees/sec in the pitch (y-z) plane applied between steps I-1 and I
CW(I)	Wetting factor applied between the I-1 and I step. If the value of this parameter remains constant from step to step use the instruction for determining this variable given in the CONSTANT orientation section. For the vertical entry (VX=VY=0) of pointed bodies an estimate of this parameter for each step can be obtained by:

a. Determining the depth of the entry body, H, below the original surface at the start of the step

b. Calculating the angle, θ'_c between a tangent to the body surface and the body axis, $z' = H$

c. Substituting into equation (C-1) to determine C_w. Where

$$\theta_c = \theta_c' + 90 - ANG$$

d. For blunt bodies, [(nose length)/diameter] < .75, increase this angle by 7% on ogives and decrease it by the same amount on cusps

DH(I) Increase in depth in feet of the center of gravity between steps I-1 and I. See instruction in the CONSTANT orientation entry section

The entry velocity at step I is taken to be the average of that at steps I-1 and I. It is only necessary to specify data cards for the first few steps in which the above parameters change. For steps larger than NVP the parameter values at step NVP are used.

The final set of data cards is used to define the grid on the surface of the entry body. The three available options for constructing a grid on the body surface are STANDARD, OGIVE and LIST. These can be used singularly, in combination with one another and can be called in arbitrary sequence. The only restriction is that the lowest point on the body should occur on that part of the grid constructed by the first option called. To indicate the desired options, the following input cards are required:

Card No.	Variable	Format
8	N	I5
9.1	option 1	3A4
.		
.		
9.N	option N	3A4

Here N is the number of options to be used. Recommended option are provided in Table C-1.

The grid representing the surface of the entry body should cover only the nose of the model and not the afterbody. In all cases the pressures on the afterbody are small. Furthermore, on bodies with sharp shoulders such as a disk cylinder, the flow separates at the edge of the model face. If the afterbody is gridded, the flow is required not to separate since the invicid boundary conditions are enforced at the centroid of each element. This is physically unrealistic and hence neglecting the afterbody is appropriate.

A description of the three available options follows. Under no circumstances should right angles be modeled directly. If the body under consideration has such a surface discontinuity, it should be modeled with a 89.9 or 90.1 degree angle.

STANDARD

This option is applicable to axisymmetric bodies or axisymmetric portions of arbitrary bodies. The user specifies rings along which nodes are located. Adjacent nodes are combined to form elements. A typical grid for a flat, circular plate is shown in the Figure C-3. The required input is:

Card No.	Variables	Format
10	NROWS, IANG, ISUP	315
11.1	R(1), Z(1)	2F10.0,15
•		
•		
11.NROWS	R(NROWS), Z(NROWS), IW(NROWS)	2F10.0,15

IANG — If IANG = 0, only half of the face is gridded as shown. If IANG = 1, the complete face is gridded

NROW — Number of grid rings

ISUP — If ISUP = 1, the stagnation element (number 1) is removed. This option is used for running pointed objects. For such bodies, R(1) should be very small (i.e., D/1000) but must be finite.

If ISUP = 0 this element is included.

R(I) — Radius of ring I in body fixed coordinates (x', y',z') in feet.

Z(I) — z' coordinate of ring is in feet.

IW(I) — number of elements in the area between rings I and I-1. Delete this variable on card 1. If IW = 0, elements are automatically selected so that they are approximately square.

LIST

This option requires that the user input the list of nodes and elements to be used in the run and hence is applicable to arbitrary bodies. The nodes can be read in any order, however, they are numbered sequentially for internal use in the code. Each element is constructed using nodes from the input list. The identification numbers of nodes defining the four corners of each element must be read in a clockwise order with respect to an observer on the outer surface of the element. The required input cards are:

Card No.	Variable	Format
10	NP, NE	215
11.1	x'(1), y'(1), z'(1)	3F10.0
.		
.		
11.NP	x'(NP), y'(NP), z'(NP)	3F10.0
12.1	IN(1,1), IN(2,1), IN(3,1), IN(4,1)	415
12.NE	IN(1,NE), IN(2,NE), IN(3,NE), IN(4,NE)	415

NP	number of node points to be read in.
NE	number of elements to be read.
x'(I), y'(I) z'(I)	location of the Ith node in body fixed coordinates (x',y',z') in feet
IN(1,I), IN(2,I), IN(3,I), IN(4,I)	Identification number of the nodes defining the four corners of the element

OGIVE

This subroutine is applicable to pointed axisymmetric bodies entering obliquely. It grids the body surface with elements having a pair of edges parallel to the water surface as shown in Figure C-4. This feature is particularly desirable for conical bodies where ANG is less than 90 degrees. Under these conditions the described code produces conical results and the complete pressure-time history can be obtained using calculated values at a single depth. This subroutine allows elements to be packed near the water surface and minimizes the need to use the local similarity assumption. Use of this subroutine is also recommended for examples in which normal force is of importance. Alignment of elements with the water surface will produce more accurate results than the STANDARD grid option. If this subroutine is used to grid non-conical bodies, the constructed element will be slightly non-planar, however, this does not seriously effect the calculations.

Card No.	Variable	Format
10	NROWS, NBODY, IANG	315
11.1	R(1), Z(1)	2F10.0
.		
.		
11.NBODY	R(NBODY), Z(NBODY)	2F10.0
12.1	H(1), B(1), IW(1)	2F10.0,15
12.NROWS	H(NROWS), B(NROWS), IW(NROWS)	2F10.0,15

Here cards 11 are used to specify the body shape while cards 12 define the grid. Up to 50 points may be used to define the body. Between these points the body is defined by linear interpolation.

The above variables are defined as:

NROWS — Number of element rows

NBODY — Number of points defining the body geometry

IANG — If IANG = 0 only the right half of the body is gridded. If IANG = 1 the entire body is gridded

R(I), Z(I) — Polar coordinates of body profile in feet. $R = (x'^2 + y'^2)^{1/2}$, $Z = z'$. R(1) and Z(1) must be zero

H(I) — z' coordinate of the upper edge of the Ith element row in the y'-z' plane in feet

B(I) — Orientation in degrees of the entry body axis with respect to the water surface at the end of step 2I. If the entry is under constant condition B(I) is equal to ANG

IW(I) — Number of elements in the Ith row. Must be specified.

SAMPLE RUNS

Four sample runs have been provided to illustrate the use of various code options. In each case a brief discussion is given of the entry problem and its particular peculiarities. This is followed by a listing of the input cards and the resulting output . In the final section of this appendix a discussion is given of the output format. Table C-2 gives a brief outline of the four cases to be present.

Example 1

A disk cylinder entering at 60 degrees and 100 ft/sec is modeled using a coarse, 12-element STANDARD grid. Consistent with the preceding discussion, the grid, shown in Sketch 3, covers only the face of the model. Noting that the distance between successive grid ring is .05 ft, an increment in depth of .0125 feet is chosen insuring that the average element is submerged in two steps. Consistent with instructions, C_w and FCF are set to 1.45 and 1 respectively.

Example 2

The vertical entry of a 45-degree half-angle cone at 20 degrees incidence is studied using an OGIVE grid with 10 rows of elements and 8 elements in each row. This problem is conically similar indicating that pressures and loads are adequately defined by considering only a single depth, hence IMAX = 1. HMIN is selected as .47814 ft which places the water level just above the 8th element row and DH is set at .02988 ft to insure that each element is submerged in two steps exactly. Pressures are calculated at HMIN + 2DH which corresponds to a level just above the 9th element row. Two values of C_w are used. These are arrived at by substituting θ_c ± ALPHA in equation (C-1). The larger value is most appropriate on the windward ray of the cone while the smaller applies to the leeward ray.

Example 3

The vertical entry of an ogive traveling at 50 ft/sec is considered under the variable entry option. A STANDARD grid consisting of 90 elements is constructed on the body nose. The entry velocity and orientation are fixed throughout but the wetting factor is allowed to vary from step to step. The value of this parameter is determined using the procedure outlined for calculating CW under the VARIABLE entry option. The increments in depth between successive steps, DH(I), are selected with care to insure that the water surface is a small distance, ε, above the upper edge of elements adjacent to the water surface at even numbered steps. In examining the total calculated drag a higher degree of reliability is placed on result obtained at even numbered steps.

Example 4

Entry of a disk cylinder at 60 degrees and 100 ft/sec is considered in this example. This case is included to demonstrate the use of no load elements in modeling the water-cavity interface. Each depth must be considered separately since the cavity shape changes in time. Accordingly, IMAX is set to 1. The STANDARD grid option is used to define elements on the face of the disk cylinder while LIST is applied to define a ring of no load elements extending from the edge of the disk cylinder surface to the effective planar surface. The depth of interest is taken to be .15 and hence HMIN and DH are defined as .125 and .0125 respectively. Several runs are made and the positions of the no loads elements are adjusted until the calculated CP value on each of the no load elements is near zero. The illustrated output is the final run only.

PROGRAM OUTPUT

Under the initial heading of I,X,Y,Z,XC,YC,ZC are listed all nodes. Column I is the node identification number, columns X,Y,Z, are the node positions in the x',y',z' coordinates and XP,YP,ZP are the node positions in x,y,z coordinates when h = 0. The second section of the output lists the constructed elements. The integers under the heading ELEMENT are the element reference numbers, XC,YC,ZC are the coordinates of the element centroid referenced to the axes x',y',z' and RC and TC are the radial location measured from the z' axis and the angular position measured from the +y' axis of the element centroid. The third section of output indicates numbers of the completed steps and the time required to execute that particular step. If a problem occurs during execution and the program does not terminate normally, the step in which the problem occurred can thus be determined.

The remainder of the output defines the loading on body at each step in the entry of the model. At each step the program calculates the time and dimensionless time ($V_I t/D$) from initial impact. This is followed by a listing of the submerged elements. The reference number (i.e., ref. no.) of an element is the original identification number assigned to it while its number (no.) is a temporary identification parameter for the particular depth in question. The integer under the heading of MOD identifies whether the element is modified or split. The codes 0,1 and 2 refers to unmodified, modified, and split elements respectively. The area of each element is that of its submerged portion. Also listed for each element are its pressure coefficient(CP), centroid depth in dimensionless time (T*), pressure (P), and total load (force). The output for each depth is concluded by providing:

FX	force along the x axis
CX	X force coefficient $(FX/((\pi\frac{D^2}{4})1/2\ \rho\ V_I^{\ 2})$
FD	drag force
CD	drag force coefficient $\sim FD/((\pi D^2/4)\frac{1}{2}\ \rho\ V_I^{\ 2})$
FN	normal force (i.e., in the -y' direction)
FD	normal force coefficient $(FN/((\frac{\pi D^2}{4})1/2\ \rho\ V_I^{\ 2})$
SMX	x component of moment taken about the model center of gravity
MX	x moment coefficient $SMX/((\frac{\pi D^3}{4})\frac{1}{2}\ \rho\ V_I^{\ 2})$
SMY	y component of the moment about model center of gravity
MY	y moment coefficient $SMY/((\frac{\pi D^3}{4})\frac{1}{2}\ \rho\ V_I^{\ 2})$
SMZ	z component of moment taken about the model center of gravity
MZ	z moment coefficient $SMZ/((\frac{\pi D^3}{4})\frac{1}{2}\ \rho\ V_I^{\ 2})$

TABLE C-1

RECOMMENDED GRID OPTIONS

TYPE OF BODY	RECOMMENDED OPTION		COMMENTS
	Vertical Entry	Oblique Entry	
Axisymmetric Pointed	STANDARD OGIVE	OGIVE	
Axisymmetric Blunt	STANDARD	STANDARD	
All other bodies	LIST	LIST	On pointed bodies, it is advisable to construct elements with edges parallel to water surface as done in OGIVE

TABLE C-2

SAMPLE RUNS

Example	Body	Conditions	Type of Entry	Grid Options	No Load Elements
1	disk cylinder	ANG = 60 VENTRY = 100 ALPHA = 0	CONSTANT orientation	STANDARD	none
2	45-degree half-angle cone	ANG = 70 VENTRY = 100 ALPHA = 20	CONSTANT orientation	OGIVE	none
3	ogive	ANG = 90 VENTRY = 50 ALPHA = 0	VARIABLE orientation	STANDARD	none
4	disk cylinder	ANG = 60 VENTRY = 100 ALPHA = 0	CONSTANT orientation	STANDARD LIST	yes

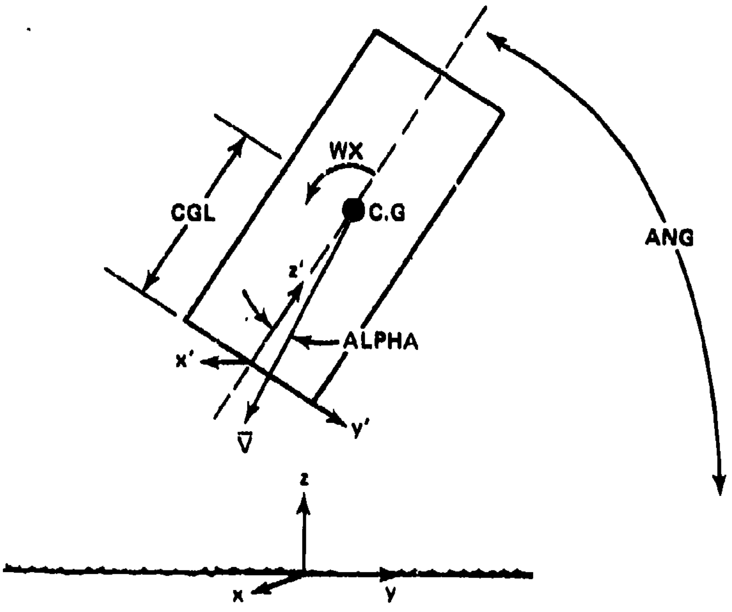

FIG. C-1

TERMS DEFINED

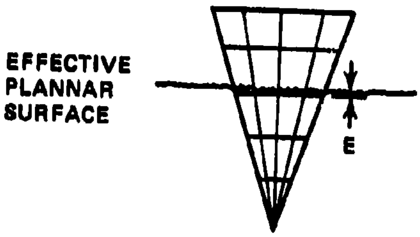

FIG. C-2 PROFILE OF CONE GRID

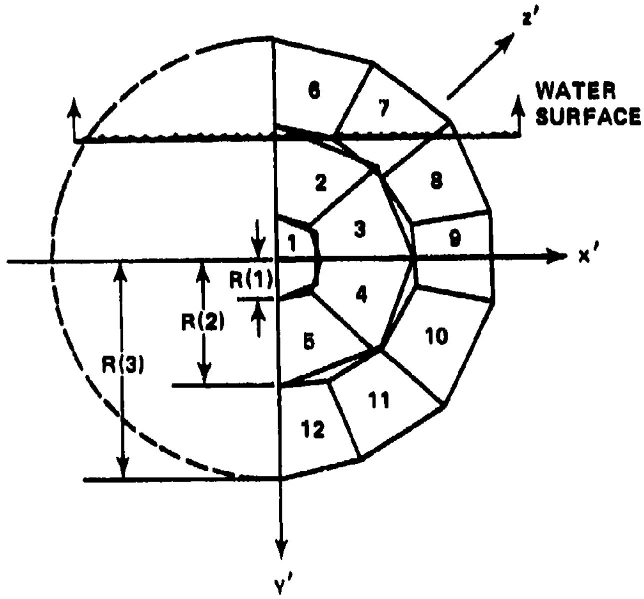

FIG. C-3 GRID OF A CIRCULAR PLATE

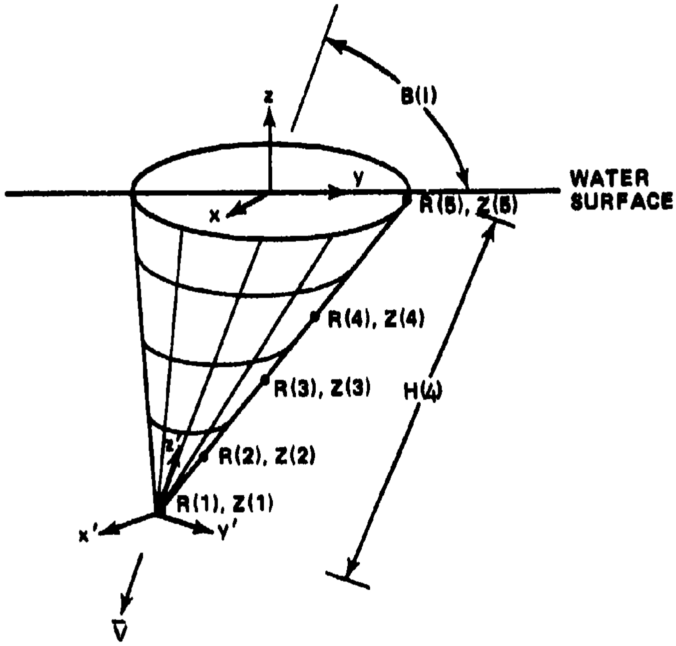

FIG. C-4

ELEMENTS HAVING A PAIR OF EDGES PARALLEL TO THE WATER

DATA CARDS FOR EXAMPLE 1

```
CONSTANT
DO"'T PRINT
SYM. TRIC
   11      .250      100.      60.      50.      0.      .0125      0.
0.         1.        0.            0
    1      1.45
    1
STANDARD
    3     0     0
.025       0.          1
.075       0.          4
.125       0.          7
```

DATA CARDS FOR EXAMPLE 2

```
CONSTANT
DON"T PRINT
SYMMETRIC
    1      1.2        100.      70.      250.      .47814     .029885   20.
0.         .67        0.             0
    2      1.359305   1.113171
    1
OGIVE
   10      3     G
0.         0.
.25        .25
1.         1.
.1         70.          8
.2         70.          8
.3         70.          8
.4         70.          8
.5         70.          8
.6         70.          8
.7         70.          8
.8         70.          8
.9         70.          8
1.0        70.          8
```

DATA CARDS FOR EXAMPLE 3

```
VARIABLE
DON'T PRINT
SYMMETRIC
   18     1.        50.       90.       300.      0.
0.        .67       0.            0
   18
0.        0.        -50.      0.        1.2622    .050001
0.        0.        -50.      0.        1.2520    .05
0.        0.        -50.      0.        1.2329    .05
0.        0.        -50.      0.        1.2242    .05
0.        0.        -50.      0.        1.2075    .05
0.        0.        -50.      0.        1.1995    .05
0.        0.        -50.      0.        1.1838    .05
0.        0.        -50.      0.        1.1761    .05
0.        0.        -50.      0.        1.1607    .05
0.        0.        -50.      0.        1.1530    .05
0.        0.        -50.      0.        1.1377    .05
0.        0.        -50.      0.        1.1300    .05
0.        0.        -50.      0.        1.1141    .05
0.        0.        -50.      0.        1.1060    .05
0.        0.        -50.      0.        1.0895    .05
0.        0.        -50.      0.        1.0811    .05
0.        0.        -50.      0.        1.0671    .05
0.        0.        -50.      0.        1.0615    .05
    1
STANDARD
   10     0    1
.0001     0.            8
.1124     .1            8
.2635     .2            8
.2785     .3            8
.3404     .4            8
.3913     .5            8
.4323     .6            8
.4645     .7            8
.4885     .8            8
.58       .870          8
```

DATA CARDS FOR EXAMPLE 4

```
CONSTANT
DON'T PRINT
SYMMETRIC
    1      .250      100.      60.       30.       .1250     .0125     0.
0.         1.        0.           13
    1      1.45
    2
STANDARD
LIST
    3     0     0
.025       0.              1
.075       0.              4
.125       0.              7
    8     7
0.          -5.0      3.23
1.22        -3.55     3.23
1.85        -2.10     3.23
1.75        -.4189    3.23
.99         .45       3.23
.80         .67       3.23
.64         .80       3.23
0.          .90       3.23
   31    32    24    23
   32    33    25    24
   33    34    26    25
   34    35    27    26
   35    36    28    27
   36    37    29    28
   37    38    30    29
```

EXAMPLE 1

```
*******PROGRAM OPTIONS*******
CONSTANT BODY ORIENTATION
DON'T PRINT
SYMMETRIC  CONFIGURATION

*******PROBLEM PARAMETERS*******
      DIAMETER  .2500 FT
      ENTRY VELOCITY     100.000(FT/SEC)
      BODY ORIENTATION ANGLE  60.00 DEGREES
INITIAL DEPTH   0.00000 FT   TERMINATION STEP 11
  INITIAL PRESSURE CORRECTION FACTOR =  1.0000
CENTROIDE COORDINATES       0.00000      0.00000      0.00000
      INCREMENT IN DEPTH    .0125000
      ANGLE OF ATTACK     0.00
         YAW ANGLE     0.00

      WETTING FACTORS
          1.45000

*******GRID OPTIONS*******
      STANDARD
```

GRID SIZE

R	Z	NUMBER
.025000	0.000000	1
.075000	0.000000	4
.125000	0.000000	7

NODE	X	Y	Z	XP	YP	ZP
1	0.0000	-.0250	0.0000	0.0000	-.1299	.0750
2	.0217	-.0125	0.0000	.0217	-.1191	.0687
3	.0217	.0125	0.0000	.0217	-.0974	.0562
4	-.0000	.0250	0.0000	-.0000	-.0866	.0500
5	0.0000	-.0250	0.0000	0.0000	-.1299	.0750
6	.0177	-.0177	0.0000	.0177	-.1236	.0713
7	.0250	.0000	0.0000	.0250	-.1083	.0625
8	.0177	.0177	0.0000	.0177	-.0929	.0537
9	-.0000	.0250	0.0000	-.0000	-.0866	.0500
10	0.0000	-.0750	0.0000	0.0000	-.1732	.1000
11	.0530	-.0530	0.0000	.0530	-.1542	.0890
12	.0750	.0000	0.0000	.0750	-.1083	.0625
13	.0530	.0530	0.0000	.0530	-.0623	.0360
14	-.0000	.0750	0.0000	-.0000	-.0433	.0250
15	0.0000	-.0750	0.0000	0.0000	-.1732	.1000
16	.0325	-.0676	0.0000	.0325	-.1668	.0963
17	.0586	-.0468	0.0000	.0586	-.1488	.0859
18	.0731	-.0167	0.0000	.0731	-.1227	.0708
19	.0731	.0167	0.0000	.0731	-.0938	.0542
20	.0586	.0468	0.0000	.0586	-.0678	.0391
21	.0325	.0676	0.0000	.0325	-.0497	.0287
22	-.0000	.0750	0.0000	-.0000	-.0433	.0250
23	0.0000	-.1250	0.0000	0.0000	-.2165	.1250
24	.0542	-.1126	0.0000	.0542	-.2058	.1188
25	.0977	-.0779	0.0000	.0977	-.1757	.1015
26	.1219	-.0278	0.0000	.1219	-.1323	.0764
27	.1219	.0278	0.0000	.1219	-.0842	.0486
28	.0977	.0779	0.0000	.0977	-.0408	.0235
29	.0542	.1126	0.0000	.0542	-.0107	.0062
30	-.0000	.1250	0.0000	-.0000	-.0000	-.0000

ELEMENT	1	2	3	4	XC	YC	ZC	RC	TC	AREA

1	1	2	3	4	.00962	.00000	0.00000	.00962	90.000	.8119E-03
2	10	11	6	5	.01915	-.04623	0.00000	.05004	157.500	.1768E-02
3	11	12	7	6	.04623	-.01915	0.00000	.05004	112.500	.1768E-02
4	12	13	8	7	.04623	.01915	0.00000	.05004	67.500	.1768E-02
5	13	14	9	8	.01915	.04623	0.00000	.05004	22.500	.1768E-02
6	23	24	16	15	.07215	-.09703	0.00000	.09952	167.143	.2169E-02
7	24	25	17	16	.06205	-.07781	0.00000	.09952	141.429	.2169E-02
8	25	26	18	17	.08967	-.04318	0.00000	.09952	115.714	.2169E-02
9	26	27	19	18	.09952	.00000	0.00000	.09952	90.000	.2169E-02
10	27	28	20	19	.08967	.04318	0.00000	.09952	64.286	.2169E-02
11	28	29	21	20	.06205	.07781	0.00000	.09952	38.571	.2169E-02
12	29	30	22	21	.07215	.09703	0.00000	.09952	12.857	.2169E-02

STEP 1 COMPLETE.CP TIME FOR STEP IS .32300

STEP 2 COMPLETE.CP TIME FOR STEP IS .57700

STEP 3 COMPLETE.CP TIME FOR STEP IS .82000

STEP 4 COMPLETE.CP TIME FOR STEP IS 1.16300

STEP 5 COMPLETE.CP TIME FOR STEP IS 1.06300

STEP 6 COMPLETE.CP TIME FOR STEP IS 2.15100

STEP 7 COMPLETE.CP TIME FOR STEP IS 2.42700

STEP 8 COMPLETE.CP TIME FOR STEP IS 2.42000

STEP 9 COMPLETE.CP TIME FOR STEP IS 2.35100

STEP 10 COMPLETE.CP TIME FOR STEP IS 1.99100

STEP 11 COMPLETE.CP TIME FOR STEP IS 1.31400

STEP 12 COMPLETE.CP TIME FOR STEP IS 1.83900

STEP 1 DEPTH = .0125000 TIME = .0000995 DIMENSIONLESS TIME .0398173 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	11	1	.1382E-03	.057485	.104207	.000000	.0067	6.84	.6637E+05	.9174E+01
2	12	1	.9818E-03	.023047	.109961	.000000	.0159	5.80	.5623E+05	.5521E+02

FX = 0. FD = .1287743E+03 FN = .1887915E-07 SMX = .1405459E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2704632 CN = .0000000 MX = .1180748 MY = 0.0000000 MZ = 0.0000000

STEP 2 DEPTH = .0250000 TIME = .0001991 DIMENSIONLESS TIME .0796345 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	10	1	.7481E-05	.096973	.075979	.000000	.0016	8.88	.8615E+05	.6445E+00
2	11	1	.1217E-02	.063621	.087643	.000000	.0201	5.65	.5476E+05	.6667E+02
3	12	2	.2035E-02	.022097	.098644	.000000	.0377	4.47	.4331E+05	.8815E+02

FX = 0. FD = .3109259E+03 FN = .2625712E-07 SMX = .2917491E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .6530341 CN = .0000000 MX = .2451029 MY = 0.0000000 MZ = 0.0000000

STEP 3 DEPTH = .0375000 TIME = .0002996 DIMENSIONLESS TIME .1194518 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	4	1	.6505E-05	.052441	.051011	.000000	.0016	10.40	.1008E+06	.6559E+00
2	5	1	.7387E-03	.029368	.058489	.000000	.0135	7.85	.7619E+05	.5629E+02
3	10	1	.6772E-03	.090536	.059312	.000000	.0148	6.44	.6246E+05	.4230E+02
4	11	2	.2156E-02	.062073	.077987	.000000	.0446	4.38	.4248E+05	.9159E+02
5	12	0	.2169E-02	.022146	.097029	.000000	.0749	3.10	.3004E+05	.6517E+02

FX = 0 FD = .6110270E+03 FN = .4325276E-07 SMX = .3460000E+02 SMY = 0 SMZ = 0

CX = 0.0000000 CD = 1.0753206 CN = .0000000 MX = .3242845 MY = 0.0000000 MZ = 0.0000000

STEP 4 DEPTH = .0500000 TIME = .0003992 DIMENSIONLESS TIME .1592690 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	4	1	.5557E-03	.047559	.034344	.000000	.0149	7.31	.7095E+05	.3943E+02
2	5	2	.1676E-02	.019420	.047527	.000000	.0359	5.78	.5603E+05	.9392E+02
3	9	1	.1736E-04	.117755	.025939	.000000	.0015	11.59	.1124E+06	.1952E+01
4	10	2	.2001E-02	.090158	.044940	.000000	.0318	5.12	.4970E+05	.9947E+02
5	11	0	.2169E-02	.062052	.077811	.000000	.0841	2.98	.2886E+05	.6261E+02
6	12	0	.2169E-02	.022146	.097029	.000000	.1147	2.60	.2520E+05	.5468E+02

FX = 0. FD = .7041272E+03 FN = .5949167E-07 SMX = .4103236E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.4789704 CN = .0000000 MX = .3447187 MY = 0.0000000 MZ = 0.0000000

STEP 5 DEPTH = .0625000 TIME = .0004977 DIMENSIONLESS TIME .1990863 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	1	.4059E-03	.009623	.009722	.000000	.0155	8.07	.7823E+05	.3176E+02
2	4	0	.1768E-02	.046234	.019151	.000000	.0305	5.21	.5056E+05	.8937E+02
3	5	0	.1768E-02	.019151	.046234	.000000	.0736	3.79	.3680E+05	.6505E+02
4	9	1	.1085E-02	.099524	.011358	.000000	.0181	6.39	.6201E+05	.6726E+02
5	10	0	.2169E-02	.089668	.043182	.000000	.0688	3.27	.3173E+05	.6883E+02
6	11	0	.2169E-02	.062052	.077811	.000000	.1239	2.43	.2359E+05	.5117E+02
7	12	0	.2169E-02	.022146	.097029	.000000	.1545	2.23	.2161E+05	.4688E+02

FX = 0. FD = .8406498E+03 FN = .7101335E-07 SMX = .3458912E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.7656053 CN = .0000000 MX = .2905885 MY = 0.0000000 MZ = 0.0000000

STEP 6 DEPTH = .0750000 TIME = .0005973 DIMENSIONLESS TIME .2389036 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.0398	5.09	.4934E+05	.4006E+02
2	2	1	.9153E-04	.014226	-.022559	-.000000	.0039	10.83	.1050E+06	.9613E+01
3	3	2	.1212E-02	.045627	-.012185	-.000000	.0204	7.33	.7107E+05	.8614E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.0703	3.88	.3760E+05	.6646E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.1135	3.04	.2947E+05	.5210E+02
6	8	1	.1679E-03	.083923	-.022230	-.000000	.0044	10.26	.9954E+05	.1672E+02
7	9	2	.2152E-02	.099377	.000209	.000000	.0402	4.96	.4810E+05	.1035E+03
8	10	0	.2169E-02	.089668	.043182	.000000	.1086	2.52	.2449E+05	.5312E+02
9	11	0	.2169E-02	.062052	.077811	.000000	.1637	2.09	.2026E+05	.4396E+02
10	12	0	.2169E-02	.022146	.097029	.000000	.1944	1.95	.1899E+05	.4121E+02

FX = 0. FD = .1025785E+04 FN = .8665847E-07 SMX = .2355469E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.1544448 CN = .0000000 MX = .1978659 MY = 0.0000000 MZ = 0.0000000

STEP 7 DEPTH = .0875000 TIME = .0006968 DIMENSIONLESS TIME .2787208 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.0796	3.90	.3787E+05	.3075E+02
2	2	1	.1029E-02	.018980	-.037436	-.000000	.0200	7.19	.6972E+05	.7175E+02
3	3	2	.1761E-02	.046211	-.019033	-.000000	.0493	5.40	.5239E+05	.9226E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.1101	3.03	.2941E+05	.5199E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.1533	2.57	.2490E+05	.4401E+02
6	7	1	.1315E-04	.058637	-.044921	-.000000	.0017	12.02	.1166E+06	.1533E+01
7	8	2	.1492E-02	.089274	-.035861	-.000000	.0225	6.35	.6160E+05	.9192E+02
8	9	0	.2169E-02	.099524	.000000	.000000	.0796	3.01	.2922E+05	.6339E+02
9	10	0	.2169E-02	.089668	.043182	.000000	.1484	2.09	.2027E+05	.4397E+02
10	11	0	.2169E-02	.062052	.077811	.000000	.2036	1.83	.1778E+05	.3858E+02
11	12	0	.2169E-02	.022146	.097029	.000000	.2342	1.74	.1692E+05	.3670E+02

FX = 0. FD = .1133788E+04 FN = .9577343E-07 SMX = .7357570E+01 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.3811142 CN = .0000000 MX = .0618121 MY = 0.0000000 MZ = 0.0000000

STEP 8 DEPTH = .1000000 TIME = .0007963 DIMENSIONLESS TIME .3185381 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.1195	2.98	.2888E+05	.2345E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.0458	4.29	.4159E+05	.7353E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.0890	3.39	.3286E+05	.5809E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.1580	2.48	.2408E+05	.4257E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.1931	2.20	.2130E+05	.3766E+02
6	6	1	.1341E-03	.022886	-.072524	-.000000	.0039	12.12	.1176E+06	.1577E+02
7	7	1	.9528E-03	.060046	-.065238	-.000000	.0155	7.19	.6973E+05	.6639E+02
8	8	2	.2162E-02	.089643	-.043068	-.000000	.0509	4.53	.4396E+05	.9504E+02
9	9	0	.2169E-02	.099524	.000000	.000000	.1195	2.18	.2110E+05	.4578E+02
10	10	0	.2169E-02	.089668	.043182	.000000	.1882	1.79	.1733E+05	.3759E+02
11	11	0	.2169E-02	.062052	.077811	.000000	.2434	1.61	.1567E+05	.3398E+02
12	12	0	.2169E-02	.022146	.097029	.000000	.2740	1.55	.1506E+05	.3267E+02

FX = 0. FD = .1125033E+04 FN = .9505129E-07 SMX = -.8170671E+01 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.3428937 CN = .0000000 MX = -.0686431 MY = 0.0000000 MZ = 0.0000000

STEP 9 DEPTH = .1125000 TIME = .0008959 DIMENSIONLESS TIME .3583553 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.1593	2.41	.2334E+05	.1895E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.0856	3.40	.3298E+05	.5831E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.1268	2.56	.2481E+05	.4386E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.1898	2.07	.2008E+05	.3549E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.2329	1.90	.1840E+05	.3252E+02
6	6	1	.1188E-02	.021401	-.086337	-.000000	.0218	6.76	.6560E+05	.7791E+02
7	7	2	.2031E-02	.062363	-.075015	-.000000	.0382	5.35	.5192E+05	.1055E+03
8	8	0	.2169E-02	.089668	-.043182	-.000000	.0905	2.51	.2436E+05	.5285E+02
9	9	0	.2169E-02	.099524	.000000	.000000	.1593	1.75	.1700E+05	.3689E+02
10	10	0	.2169E-02	.089668	.043182	.000000	.2280	1.54	.1490E+05	.3233E+02
11	11	0	.2169E-02	.062052	.077811	.000000	.2832	1.42	.1379E+05	.2992E+02
12	12	0	.2169E-02	.022146	.097029	.000000	.3138	1.38	.1339E+05	.2904E+02

FX = 0. FD = .1107051E+04 FN = .9353789E-07 SMX = -.2367068E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.3251276 CN = .0000000 MX = -.1989611 MY = 0.0000000 MZ = 0.0000000

STEP 10 DEPTH = .1250000 TIME = .0009954 DIMENSIONLESS TIME .3981776 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.1991	1.86	.1804E+05	.1465E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.1254	2.27	.2201E+05	.3891E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.1686	1.89	.1836E+05	.3246E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.2296	1.67	.1620E+05	.2864E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.2727	1.58	.1534E+05	.2712E+02
6	6	0	.2169E-02	.022146	-.097029	-.000000	.0445	3.34	.3238E+05	.7026E+02
7	7	0	.2169E-02	.062052	-.077811	-.000000	.0752	2.33	.2264E+05	.4911E+02
8	8	0	.2169E-02	.089668	-.043182	-.000000	.1383	1.63	.1580E+05	.3429E+02
9	9	0	.2169E-02	.099524	.000000	.000000	.1991	1.39	.1347E+05	.2923E+02
10	10	0	.2169E-02	.089668	.043182	.000000	.2679	1.28	.1244E+05	.2700E+02
11	11	0	.2169E-02	.062052	.077811	.000000	.3230	1.21	.1178E+05	.2555E+02
12	12	0	.2169E-02	.022146	.097029	.000000	.3536	1.19	.1155E+05	.2505E+02

FX = 0. FD = .8045290E+03 FN = .6797563E-07 SMX = -.1430395E+02 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.6897432 CN = .0000000 MX = -.1201697 MY = 0.0000000 MZ = 0.0000000

STEP 11 DEPTH = .1375000 TIME = .0010950 DIMENSIONLESS TIME .4379899 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.2389	1.51	.1463E+05	.1188E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.1653	1.57	.1521E+05	.2689E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.2084	1.49	.1446E+05	.2556E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.2694	1.41	.1370E+05	.2422E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.3125	1.37	.1332E+05	.2354E+02
6	6	0	.2169E-02	.022146	-.097029	-.000000	.0844	1.62	.1570E+05	.3406E+02
7	7	0	.2169E-02	.062052	-.077811	-.000000	.1156	1.41	.1369E+05	.2971E+02
8	8	0	.2169E-02	.089668	-.043182	-.000000	[illegible]	[illegible]	[illegible]	[illegible]

9	9	0	.2169E-02	.999524	.000000	.000000	.2389	1.17	.1134E+05	.2459E+02
10	10	0	.2169E-02	.989668	.043182	.000000	.3077	1.12	.1082E+05	.2347E+02
11	11	0	.2169E-02	.962052	.077811	.000000	.3628	1.07	.1040E+05	.2255E+02
12	12	0	.2169E-02	.922146	.097029	.000000	.3934	1.06	.1026E+05	.2226E+02

FX = 0. FD = .5911595E+03 FN = .4994672E-07 SMX = -.4055373E+01 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.2416057 CN = .0000000 MX = -.0340698 MY = 0.0000000 MZ = 0.0000000

```
                    EXAMPLE 2
        *******PROGRAM OPTIONS*******
        CONSTANT BODY ORIENTATION
        DON'T PRINT
        SYMMETRIC  CONFIGURATION

       *******PROBLEM PARAMETERS*******
            DIAMETER 1.2000 FT
            ENTRY VELOCITY    100.000(FT/SEC)
            BODY ORIENTATION ANGLE  70.00 DEGREES
      INITIAL DEPTH    .47814 FT   TERMINATION STEP  1
           INITIAL PRESSURE CORRECTION FACTOR =   .6700
CENTROIDE COORDINATES      0.00000      0.00000      0.00000
           INCREMENT IN DEPTH   .0298850
            ANGLE OF ATTACK   20.00
               YAW ANGLE    0.00

            WETTING FACTORS
                1.35931
                1.11317

       *******GRID OPTIONS*******
            OGIVE

            SYMMETRY =      0
                       BODY PROFILE
                  R             Z
            0.000000      0.000000
             .250000       .250000
            1.000000      1.000000
                       GRID SIZE
                  H             B        NUMBER
             .100000     70.000000         8
             .200000     70.000000         8
             .300000     70.000000         8
             .400000     70.000000         8
             .500000     70.000000         8
             .600000     70.000000         8
             .700000     70.000000         8
             .800000     70.000000         8
             .900000     70.000000         8
            1.000000     70.000000         8
```

NODE	X	Y	Z	XP	YP	ZP
1	0.0000	-.0001	.0001	0.0000	-.0001	-.4780
2	.0000	-.0001	.0001	.0000	-.0001	-.4780
3	.0001	-.0001	.0001	.0001	-.0000	-.4780
4	.0001	-.0000	.0001	.0001	-.0000	-.4780
5	.0001	.0000	.0001	.0001	.0000	-.4780
6	.0001	.0000	.0001	.0001	.0001	-.4781
7	.0001	.0001	.0001	.0001	.0001	-.4781
8	.0000	.0001	.0001	.0000	.0001	-.4781
9	-.0000	.0001	.0001	-.0000	.0001	-.4781
10	0.0000	-.0466	.0466	0.0000	-.0279	-.4184
11	.0182	-.0440	.0476	.0182	-.0250	-.4184
12	.0358	-.0358	.0506	.0358	-.0163	-.4184
13	.0516	-.0214	.0558	.0516	-.0010	-.4184
14	.0636	.0000	.0636	.0636	.0218	-.4184
15	.0683	.0283	.0739	.0683	.0518	-.4184
16	.0606	.0606	.0856	.0606	.0862	-.4184
17	.0367	.0885	.0958	.0367	.1160	-.4184
18	-.0000	.1000	.1000	-.0000	.1282	-.4184
19	0.0000	-.0933	.0933	0.0000	-.0557	-.3586
20	.0364	-.0879	.0952	.0364	-.0501	-.3586
21	.0715	-.0715	.1012	.0715	-.0326	-.3586

22	.1032	-.0427	.1117	.1032	-.0020	-.3586
23	.1272	.0000	.1272	.1272	.0435	-.3586
24	.1365	.0566	.1478	.1365	.1037	-.3586
25	.1211	.1211	.1713	.1211	.1724	-.3586
26	.0733	.1771	.1917	.0733	.2319	-.3586
27	-.0000	.2000	.2000	-.0000	.2563	-.3586
28	0.0000	-.1399	.1399	0.0000	-.0836	-.2988
29	.0546	-.1319	.1428	.0546	-.0751	-.2988
30	.1073	-.1073	.1518	.1073	-.0489	-.2988
31	.1547	-.0641	.1675	.1547	-.0029	-.2988
32	.1908	.0000	.1908	.1908	.0653	-.2988
33	.2048	.0848	.2217	.2048	.1555	-.2988
34	.1817	.1817	.2569	.1817	.2586	-.2988
35	.1100	.2656	.2875	.1100	.3479	-.2988
36	-.0000	.3000	.3000	-.0000	.3845	-.2988
37	0.0000	-.1865	.1865	0.0000	-.1115	-.2391
38	.0729	-.1759	.1904	.0729	-.1002	-.2391
39	.1431	-.1431	.2023	.1431	-.0652	-.2391
40	.2063	-.0855	.2233	.2063	-.0039	-.2391
41	.2544	.0000	.2544	.2544	.0870	-.2391
42	.2731	.1131	.2956	.2731	.2074	-.2391
43	.2422	.2422	.3426	.2422	.3448	-.2391
44	.1467	.3541	.3833	.1457	.4639	-.2391
45	-.0000	.4000	.4000	-.0000	.5127	-.2391
46	0.0000	-.2332	.2332	0.0000	-.1393	-.1793
47	.0911	-.2199	.2380	.0911	-.1252	-.1793
48	.1788	-.1788	.2529	.1788	-.0816	-.1793
49	.2579	-.1068	.2791	.2579	-.0049	-.1793
50	.3180	.0000	.3180	.3180	.1088	-.1793
51	.3414	.1414	.3695	.3414	.2592	-.1793
52	.3028	.3028	.4282	.3028	.4310	-.1793
53	.1834	.4427	.4791	.1834	.5798	-.1793
54	-.0000	.5000	.5000	-.0000	.6409	-.1793
55	0.0000	-.2798	.2798	0.0000	-.1672	-.1195
56	.1093	-.2638	.2856	.1093	-.1503	-.1195
57	.2146	-.2146	.3035	.2146	-.0979	-.1195
58	.3095	-.1282	.3350	.3095	-.0059	-.1195
59	.3816	.0000	.3816	.3816	.1305	-.1195
60	.4096	.1697	.4434	.4096	.3111	-.1195
61	.3634	.3634	.5139	.3634	.5172	-.1195
62	.2200	.5312	.5759	.2200	.6958	-.1195
63	-.0000	.6000	.6000	-.0000	.7690	-.1195
64	0.0000	-.3264	.3264	0.0000	-.1951	-.0598
65	.1275	-.3078	.3332	.1275	-.1753	-.0598
66	.2504	-.2504	.3541	.2504	-.1142	-.0598
67	.3610	-.1495	.3908	.3610	-.0069	-.0598
68	.4452	.0000	.4452	.4452	.1523	-.0598
69	.4779	.1980	.5173	.4779	.3629	-.0598
70	.4239	.4239	.5995	.4239	.6034	-.0598
71	.2567	.6197	.6708	.2567	.8118	-.0598
72	-.0000	.7000	.7000	-.0000	.8972	-.0598
73	0.0000	-.3730	.3730	0.0000	-.2230	-.0000
74	.1457	-.3518	.3808	.1457	-.2003	-.0000
75	.2861	-.2861	.4047	.2861	-.1305	-.0000
76	.4126	-.1709	.4466	.4126	-.0079	-.0000
77	.5088	.0000	.5088	.5088	.1740	-.0000
78	.5462	.2262	.5912	.5462	.4148	-.0000
79	.4845	.4845	.6852	.4845	.6896	-.0000
80	.2934	.7083	.7666	.2934	.9277	-.0000
81	-.0000	.8000	.8000	-.0000	1.0254	-.0000
82	0.0000	-.4197	.4197	0.0000	-.2508	.0598
83	.1639	-.3958	.4284	.1639	-.2254	.0598
84	.3219	-.3219	.4553	.3219	-.1468	.0598
85	.4642	-.1923	.5024	.4642	-.0088	.0598
86	.5724	.0000	.5724	.5724	.1958	.0598
87	.6144	.2545	.6651	.6144	.4666	.0598

88	.5450	.5450	.7708	.5450	.7758	.0598
89	.3300	.7968	.8624	.3300	1.0437	.0598
90	-.0000	.9000	.9000	-.0000	1.1535	.0598
91	0.0000	-.4663	.4663	0.0000	-.2787	.1195
92	.1821	-.4397	.4760	.1821	-.2504	.1195
93	.3577	-.3577	.5058	.3577	-.1631	.1195
94	.5158	-.21[illegible]	.5583	.5158	-.0098	.1195
95	.6360	.0000	.6360	.6360	.2175	.1195
96	.6827	.2828	.7390	.6827	.5185	.1195
97	.6056	.6056	.8565	.6056	.8620	.1195
98	.3667	.8853	.9583	.3667	1.1597	.1195
99	-.0000	1.0000	1.0000	-.0000	1.2817	.1195

ELEMENT	1	2	3	4	XC	YC	ZC	RC	TC	AREA
1	10	11	2	1	.00607	-.03020	.03141	.03081	168.633	.6065E-03
2	11	12	3	2	.01799	-.02658	.03273	.03210	145.903	.6579E-03
3	12	13	4	3	.02912	-.01904	.03547	.03479	123.189	.7717E-03
4	13	14	5	4	.03839	-.00712	.03981	.03905	100.508	.9703E-03
5	14	15	6	5	.04396	.00943	.04583	.04496	77.897	.1284E-02
6	15	16	7	6	.04294	.02961	.05318	.05216	55.411	.1729E-02
7	16	17	8	7	.03241	.04970	.06049	.05933	33.111	.2243E-02
8	17	18	9	8	.01222	.06284	.06528	.06402	11.007	.2619E-02
9	19	20	11	10	.01417	-.07047	.07329	.07188	168.633	.1820E-02
10	20	21	12	11	.04199	-.06202	.07636	.07490	145.903	.1974E-02
11	21	22	13	12	.06794	-.04444	.08276	.08118	123.189	.2315E-02
12	22	23	14	13	.08958	-.01662	.09289	.09111	100.508	.2911E-02
13	23	24	15	14	.10257	.02199	.10694	.10490	77.897	.3853E-02
14	24	25	16	15	.10020	.06910	.12409	.12172	55.411	.5188E-02
15	25	26	17	16	.07562	.11596	.14114	.13844	33.111	.6728E-02
16	26	27	18	17	.02852	.14664	.15231	.14938	11.007	.7656E-02
17	28	29	20	19	.02307	-.11477	.11936	.11706	168.633	.3033E-02
18	29	30	21	20	.06838	-.10101	.12436	.12198	145.903	.3290E-02
19	30	31	22	21	.11064	-.07237	.13479	.13220	123.189	.3858E-02
20	31	32	23	22	.14590	-.02706	.15128	.14838	100.508	.4851E-02
21	32	33	24	23	.16704	.03582	.17416	.17084	77.897	.6422E-02
22	33	34	25	24	.16319	.11253	.20208	.19822	55.411	.8647E-02
23	34	35	26	25	.12316	.18885	.22986	.22546	33.111	.1121E-01
24	35	36	27	26	.04645	.23881	.24805	.24328	11.007	.1309E-01
25	37	38	29	28	.03209	-.15964	.16602	.16283	168.633	.4246E-02
26	38	39	30	29	.09511	-.14050	.17299	.16967	145.903	.4605E-02
27	39	40	31	30	.15390	-.10066	.18749	.18389	123.189	.5402E-02
28	40	41	32	31	.20294	-.03764	.21042	.20640	100.508	.6792E-02
29	41	42	33	32	.23235	.04982	.24226	.23763	77.897	.8990E-02
30	42	43	34	33	.22699	.15653	.28110	.27572	55.411	.1211E-01
31	43	44	35	34	.17131	.26269	.31973	.31361	33.111	.1570E-01
32	44	45	36	35	.06461	.33217	.34503	.33840	11.007	.1833E-01
33	46	47	38	37	.04115	-.20478	.21289	.20880	168.633	.5459E-02
34	47	48	39	38	.12196	-.18016	.22182	.21756	145.903	.5921E-02
35	48	49	40	39	.19734	-.12908	.24041	.23580	123.189	.6965E-02
36	49	50	41	40	.26022	-.04827	.26982	.26466	100.508	.8733E-02
37	50	51	42	41	.29794	.06389	.31064	.30471	77.897	.1156E-01
38	51	52	43	42	.29106	.20071	.36044	.35756	55.411	.1556E-01
39	52	53	44	43	.21967	.33684	.40999	.40214	33.111	.2018E-01
40	53	54	45	44	.08285	.42594	.44242	.43392	11.007	.2357E-01
41	55	56	47	46	.05023	-.24985	.25984	.25485	168.633	.6672E-02
42	56	57	48	47	.14886	-.21990	.27074	.26555	145.903	.7237E-02
43	57	58	49	48	.24086	-.15755	.29344	.28781	123.189	.8489E-02
44	58	59	50	49	.31762	-.05891	.32934	.32304	100.508	.1067E-01
45	59	60	51	50	.36365	.07798	.37916	.37192	77.897	.1413E-01
46	60	61	52	51	.35526	.24498	.43995	.43154	55.411	.1902E-01
47	61	62	53	52	.26812	.41113	.50042	.49083	33.111	.2467E-01
48	62	63	54	53	.10112	.51989	.54000	.52963	11.007	.2880E-01
49	64	65	56	55	.05931	-.29505	.30685	.30095	168.633	.7885E-02
50	65	66	57	56	.17579	-.25968	.31972	.31358	145.903	.8553E-02
51	66	67	58	57	.28443	-.18605	.34652	.33988	123.189	.1003E-01

52	67	68	59	58	.37507	-.06957	.38891	.38147	100.508	.1261E-01
53	68	69	60	59	.42943	.09289	.44775	.43920	77.897	.1670E-01
54	69	70	61	60	.41953	.28930	.51953	.50960	55.411	.2248E-01
55	70	71	62	61	.31662	.48550	.59094	.57962	33.111	.2915E-01
56	71	72	63	62	.11942	.61394	.63769	.62544	11.007	.3404E-01
57	73	74	65	64	.06841	-.34027	.35388	.34708	168.633	.9098E-02
58	74	75	66	65	.20274	-.29948	.36873	.36165	145.903	.9869E-02
59	75	76	67	66	.32883	-.21456	.39963	.39197	123.189	.1158E-01
60	76	77	68	67	.43257	-.08023	.44853	.43994	100.508	.1455E-01
61	77	78	69	68	.49526	.10620	.51638	.50652	77.897	.1926E-01
62	78	79	70	69	.48383	.33364	.59916	.58771	55.411	.2594E-01
63	79	80	71	70	.36516	.55992	.68152	.66847	33.111	.3364E-01
64	80	81	72	71	.13772	.70884	.73543	.72131	11.007	.3928E-01
65	82	83	74	73	.07750	-.38552	.40093	.39323	168.633	.1031E-01
66	83	84	75	74	.22969	-.33930	.41775	.40973	145.903	.1118E-01
67	84	85	76	75	.37165	-.24309	.45277	.44409	123.189	.1312E-01
68	85	86	77	76	.49008	-.09090	.50816	.49844	100.508	.1649E-01
69	86	87	78	77	.56111	.12032	.58504	.57386	77.897	.2183E-01
70	87	88	79	78	.54816	.37600	.67883	.66586	55.411	.2940E-01
71	88	89	80	79	.41371	.63437	.77214	.75735	33.111	.3813E-01
72	89	90	81	80	.15683	.80218	.83322	.81722	11.007	.4452E-01
73	91	92	83	82	.08660	-.43077	.44800	.43939	168.633	.1152E-01
74	92	93	84	83	.25666	-.37913	.46679	.45783	145.903	.1250E-01
75	93	94	85	84	.41528	-.27163	.50592	.49622	123.189	.1466E-01
76	94	95	86	85	.54761	-.10157	.56782	.55695	100.508	.1844E-01
77	95	96	87	86	.62698	.13445	.65372	.64123	77.897	.2440E-01
78	96	97	88	87	.61251	.42237	.75852	.74402	55.411	.3286E-01
79	97	98	89	88	.46227	.70884	.86278	.84626	33.111	.4261E-01
80	98	99	90	89	.17435	.89635	.93103	.91315	11.007	.4975E-01

STEP 1 COMPLETE.CP TIME FOR STEP IS 37.63400

STEP 2 COMPLETE.CP TIME FOR STEP IS 37.32200

STEP 3 COMPLETE.CP TIME FOR STEP IS 45.01900

STEP 2 DEPTH = .5378502 TIME = .0042107 DIMENSIONLESS TIME .3508952 WETTING FACTOR = 1.3593050

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.6865E-03	.006 '?	-.030202	.031410	.3249	.83	.8013E+04	.4860E+01
2	2	0	.6579E-03	.0179 ?	-.026581	.032727	.3249	.76	.7362E+04	.4844E+01
3	3	0	.7717E-03	.029115	-.019044	.035471	.3249	.70	.6832E+04	.5272E+01
4	4	0	.9703E-03	.038394	-.007121	.039810	.3249	.76	.7396E+04	.7176E+01
5	5	0	.1284E-02	.043958	.009426	.045833	.3249	.98	.9499E+04	.1220E+02
6	6	0	.1729E-02	.042944	.029613	.053180	.3249	1.31	.1271E+05	.2198E+02
7	7	0	.2243E-02	.032410	.049697	.060490	.3249	1.64	.1590E+05	.3566E+02
8	8	0	.2619E-02	.012224	.062844	.065275	.3249	1.84	.1787E+05	.4680E+02
9	9	0	.1820E-02	.014167	-.070471	.073289	.2903	.83	.8003E+04	.1456E+02
10	10	0	.1974E-02	.041987	-.062022	.076364	.2903	.79	.7682E+04	.1516E+02
11	11	0	.2315E-02	.067936	-.044436	.082764	.2903	.79	.7618E+04	.1764E+02
12	12	0	.2911E-02	.089585	-.016617	.092890	.2903	.88	.8544E+04	.2487E+02
13	13	0	.3853E-02	.102568	.021994	.106943	.2903	1.11	.1078E+05	.4155E+02
14	14	0	.5188E-02	.100202	.069097	.124087	.2903	1.44	.1396E+05	.7241E+02
15	15	0	.6728E-02	.075624	.115960	.141144	.2903	1.76	.1709E+05	.1150E+03
16	16	0	.7856E-02	.028522	.146636	.152309	.2903	1.96	.1904E+05	.1495E+03
17	17	0	.3033E-02	.023072	-.114767	.119356	.2522	.80	.7727E+04	.2343E+02
18	18	0	.3290E-02	.068379	-.101008	.124364	.2522	.78	.7611E+04	.2504E+02
19	19	0	.3858E-02	.110638	-.072368	.134788	.2522	.81	.7861E+04	.3033E+02
20	20	0	.4851E-02	.145895	-.027061	.151278	.2522	.94	.9090E+04	.4410E+02
21	21	0	.6422E-02	.167040	.035820	.174165	.2522	1.19	.1156E+05	.7424E+02
22	22	0	.8647E-02	.163186	.112529	.202085	.2522	1.54	.1492E+05	.1290E+03
23	23	0	.1121E-01	.123159	.188858	.229863	.2522	1.88	.1821E+05	.2042E+03
24	24	0	.1309E-01	.046450	.238807	.248846	.2522	2.09	.2027E+05	.2654E+03
25	25	0	.4246E-02	.032093	-.159638	.166021	.2135	.76	.7397E+04	.3141E+02
26	26	0	.4606E-02	.095113	-.140499	.172987	.2135	.77	.7435E+04	.3424E+02
27	27	0	.5402E-02	.153895	-.100662	.187487	.2135	.82	.7941E+04	.4290E+02

28	28	0	.6792E-02	.202937	-.037642	.210424	.2135	.98	.9459E+04	.6425E+02
29	29	0	.8990E-02	.232349	.049824	.242259	.2135	1.26	.1223E+05	.1099E+03
30	30	0	.1211E-01	.226988	.156526	.281095	.2135	1.64	.1590E+05	.1924E+03
31	31	0	.1570E-01	.171312	.262685	.319734	.2135	2.01	.1950E+05	.3061E+03
32	32	0	.1833E-01	.064611	.332175	.345026	.2135	2.24	.2177E+05	.3991E+03
33	33	0	.5459E-02	.041152	-.204701	.212886	.1747	.73	.7071E+04	.3860E+02
34	34	0	.5921E-02	.121962	-.180160	.221818	.1747	.75	.7249E+04	.4293E+02
35	35	0	.6945E-02	.197337	-.129077	.240411	.1747	.82	.7998E+04	.5555E+02
36	36	0	.8733E-02	.260223	-.048267	.269823	.1747	1.01	.9825E+04	.8580E+02
37	37	0	.1156E-01	.297937	.063889	.310645	.1747	1.34	.1296E+05	.1498E+03
38	38	0	.1556E-01	.291062	.208718	.360444	.1747	1.76	.1707E+05	.2657E+03
39	39	0	.2018E-01	.219670	.336837	.409990	.1747	2.18	.2113E+05	.4265E+03
40	40	0	.2357E-01	.082849	.425942	.442421	.1747	2.45	.2372E+05	.5590E+03
41	41	0	.6672E-02	.050229	-.249851	.259842	.1359	.70	.6760E+04	.4510E+02
42	42	0	.7237E-02	.148863	-.219897	.270744	.1359	.73	.7080E+04	.5124E+02
43	43	0	.8409E-02	.240863	-.157547	.293437	.1359	.83	.8086E+04	.6864E+02
44	44	0	.1067E-01	.317619	-.058913	.329337	.1359	1.06	.1027E+05	.1096E+03
45	45	0	.1413E-01	.363651	.077980	.379163	.1359	1.43	.1389E+05	.1962E+03
46	46	0	.1902E-01	.355261	.244980	.439945	.1359	1.92	.1862E+05	.3542E+03
47	47	0	.2467E-01	.260122	.411132	.500420	.1359	2.41	.2334E+05	.5759E+03
48	48	0	.2880E-01	.101123	.519890	.540005	.1359	2.72	.2638E+05	.7599E+03
49	49	0	.7885E-02	.059315	-.295048	.306846	.0970	.67	.6471E+04	.5102E+02
50	50	0	.8553E-02	.175792	-.259676	.319721	.0970	.72	.6942E+04	.5938E+02
51	51	0	.1003E-01	.284434	-.186847	.346519	.0970	.85	.8241E+04	.8267E+02
52	52	0	.1261E-01	.375075	-.069570	.388913	.0970	1.12	.1088E+05	.1373E+03
53	53	0	.1670E-01	.429434	.092087	.447752	.0970	1.57	.1519E+05	.2536E+03
54	54	0	.2248E-01	.419526	.289296	.519530	.0970	2.15	.2086E+05	.4690E+03
55	55	0	.2915E-01	.316625	.485504	.590944	.0970	2.74	.2662E+05	.7760E+03
56	56	0	.3404E-01	.119416	.613936	.637689	.0970	3.13	.3037E+05	.1034E+04
57	57	0	.9098E-02	.068407	-.340273	.353880	.0581	.64	.6176E+04	.5619E+02
58	58	0	.9869E-02	.202737	-.299479	.368728	.0581	.70	.6831E+04	.6741E+02
59	59	0	.1158E-01	.328033	-.214565	.399634	.0581	.88	.8517E+04	.9858E+02
60	60	0	.1455E-01	.432567	-.080234	.448526	.0581	1.22	.1185E+05	.1725E+03
61	61	0	.1926E-01	.495258	.106202	.516383	.0581	1.79	.1735E+05	.3343E+03
62	62	0	.2594E-01	.483831	.333639	.599164	.0581	2.56	.2487E+05	.6451E+03
63	63	0	.3364E-01	.365157	.559922	.681524	.0581	3.38	.3276E+05	.1102E+04
64	64	0	.3928E-01	.137720	.708041	.735435	.0581	3.92	.3891E+05	.1493E+04
65	65	0	.1031E-01	.077502	-.385516	.400932	.0191	.40	.3836E+04	.3955E+02
66	66	0	.1118E-01	.229694	-.339298	.417754	.0191	.42	.4088E+04	.4572E+02
67	67	0	.1312E-01	.371649	-.243094	.452770	.0191	.51	.4948E+04	.6491E+02
68	68	0	.1649E-01	.490082	-.090902	.508163	.0191	.75	.7312E+04	.1206E+03
69	69	0	.2183E-01	.561189	.120323	.585043	.0191	1.32	.1280E+05	.2794E+03
70	70	0	.2940E-01	.548162	.378001	.678830	.0191	2.37	.2295E+05	.6747E+03
71	71	0	.3813E-01	.413709	.634371	.772141	.0191	3.79	.3676E+05	.1402E+04
72	72	0	.4452E-01	.156031	.802183	.933220	.0191	4.93	.4781E+05	.2128E+04

FX = 0. FD = .2511962E+05 FN = .1666419E+05 SMX = .2074813E+05 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 2.2898635 CN = 1.5190882 MX = 1.5761389 MY = 0.0000000 MZ = 0.0000000

STEP 2 DEPTH = .5378502 TIME = .0051418 DIMENSIONLESS TIME .4284818 WETTING FACTOR = 1.1131710

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.6065E-03	.006072	-.030202	.031410	.3968	.68	.6629E+04	.4021E+01
2	2	0	.6579E-03	.017995	-.026581	.032727	.3968	.62	.5972E+04	.3929E+01
3	3	0	.7717E-03	.029115	-.019044	.035471	.3968	.56	.5429E+04	.4190E+01
4	4	0	.9703E-03	.038394	-.007121	.039810	.3968	.62	.5973E+04	.5796E+01
5	5	0	.1284E-02	.043958	.009426	.045833	.3968	.83	.8056E+04	.1034E+02
6	6	0	.1729E-02	.042944	.029613	.053180	.3968	1.16	.1123E+05	.1942E+02
7	7	0	.2243E-02	.032410	.049697	.060490	.3968	1.48	.1439E+05	.3227E+02
8	8	0	.2619E-02	.012224	.062844	.065275	.3968	1.68	.1634E+05	.4278E+02
9	9	0	.1820E-02	.014167	-.070471	.073289	.3545	.68	.6601E+04	.1201E+02
10	10	0	.1974E-02	.041987	-.062022	.076364	.3545	.65	.6264E+04	.1236E+02
11	11	0	.2315E-02	.067936	-.044436	.082764	.3545	.64	.6170E+04	.1428E+02
12	12	0	.2911E-02	.089585	-.016617	.092890	.3545	.73	.7048E+04	.2052E+02
13	13	0	.3853E-02	.102568	.021994	.106943	.3545	.95	.9224E+04	.3554E+02
14	14	0	.5188E-02	.100202	.069097	.124087	.3545	1.27	.1232E+05	.6393E+02

15	15	0	.6728E-02	.075624	.115960	.141144	.3545	1.59	.1538E+05	.1035E+03
16	16	0	.7856E-02	.028522	.146636	.152389	.3545	1.78	.1728E+05	.1358E+03
17	17	0	.3033E-02	.023072	-.114767	.119356	.3079	.65	.6280E+04	.1904E+02
18	18	0	.3290E-02	.068379	-.101008	.124364	.3079	.63	.6137E+04	.2019E+02
19	19	0	.3858E-02	.110638	-.072368	.134788	.3079	.65	.6333E+04	.2444E+02
20	20	0	.4851E-02	.145895	-.027051	.151278	.3079	.77	.7479E+04	.3629E+02
21	21	0	.6422E-02	.167040	.035820	.174165	.3079	1.01	.9840E+04	.6319E+02
22	22	0	.8647E-02	.163186	.112529	.202085	.3079	1.35	.1307E+05	.1130E+03
23	23	0	.1121E-01	.123159	.188850	.229863	.3079	1.67	.1624E+05	.1821E+03
24	24	0	.1309E-01	.046456	.238807	.248046	.3079	1.88	.1822E+05	.2385E+03
25	25	0	.4246E-02	.032093	-.159638	.166021	.2607	.61	.5874E+04	.2494E+02
26	26	0	.4606E-02	.095113	-.140499	.172987	.2607	.61	.5872E+04	.2704E+02
27	27	0	.5402E-02	.153895	-.100662	.187487	.2607	.65	.6296E+04	.3401E+02
28	28	0	.6792E-02	.202937	-.037642	.210424	.2607	.79	.7687E+04	.5221E+02
29	29	0	.8990E-02	.232349	.049824	.242259	.2607	1.06	.1029E+05	.9249E+02
30	30	0	.1211E-01	.226988	.156526	.281695	.2607	1.42	.1376E+05	.1666E+03
31	31	0	.1578E-01	.171312	.262685	.319734	.2607	1.77	.1718E+05	.2697E+03
32	32	0	.1833E-01	.064611	.332175	.345026	.2607	1.99	.1934E+05	.3545E+03
33	33	0	.5459E-02	.041152	-.204701	.212886	.2134	.56	.5432E+04	.2965E+02
34	34	0	.5921E-02	.121962	-.180160	.221818	.2134	.57	.5550E+04	.3287E+02
35	35	0	.6945E-02	.197337	-.129077	.240411	.2134	.64	.6179E+04	.4291E+02
36	36	0	.8733E-02	.260223	-.049267	.269823	.2134	.81	.7822E+04	.6831E+02
37	37	0	.1156E-01	.297937	.063889	.316645	.2134	1.10	.1072E+05	.1239E+03
38	38	0	.1556E-01	.291062	.200710	.360444	.2134	1.50	.1455E+05	.2265E+03
39	39	0	.2018E-01	.219670	.336837	.409990	.2134	1.89	.1835E+05	.3704E+03
40	40	0	.2357E-01	.082849	.425942	.442421	.2134	2.14	.2078E+05	.4897E+03
41	41	0	.6672E-02	.050229	-.249851	.259842	.1659	.51	.4938E+04	.3294E+02
42	42	0	.7237E-02	.148863	-.219897	.270744	.1659	.53	.5171E+04	.3742E+02
43	43	0	.8489E-02	.240863	-.157547	.293437	.1659	.62	.6001E+04	.5094E+02
44	44	0	.1067E-01	.317619	-.058913	.329337	.1659	.82	.7922E+04	.8455E+02
45	45	0	.1413E-01	.363651	.077980	.379163	.1659	1.15	.1120E+05	.1582E+03
46	46	0	.1902E-01	.355261	.244980	.439945	.1659	1.60	.1554E+05	.2957E+03
47	47	0	.2467E-01	.268122	.411132	.500420	.1659	2.05	.1991E+05	.4912E+03
48	48	0	.2883E-01	.101123	.519890	.540005	.1659	2.34	.2273E+05	.6547E+03
49	49	0	.7885E-02	.059315	-.295048	.306846	.1184	.45	.4339E+04	.3421E+02
50	50	0	.8553E-02	.175792	-.259676	.319721	.1184	.48	.4680E+04	.4003E+02
51	51	0	.1003E-01	.284434	-.186047	.346519	.1184	.59	.5717E+04	.5735E+02
52	52	0	.1261E-01	.375075	-.069570	.388913	.1184	.82	.7969E+04	.1005E+03
53	53	0	.1670E-01	.429434	.092087	.447752	.1184	1.21	.1178E+05	.1967E+03
54	54	0	.2248E-01	.419526	.289296	.519530	.1184	1.74	.1698E+05	.3800E+03
55	55	0	.2915E-01	.316625	.485504	.590944	.1184	2.28	.2216E+05	.6460E+03
56	56	0	.3404E-01	.119416	.613936	.637589	.1184	2.64	.2561E+05	.8717E+03
57	57	0	.9098E-02	.068407	-.340273	.353880	.0709	.35	.3423E+04	.3114E+02
58	58	0	.9869E-02	.202737	-.293479	.368726	.0709	.40	.3857E+04	.3807E+02
59	59	0	.1158E-01	.328033	-.214565	.399634	.0709	.53	.5105E+04	.5909E+02
60	60	0	.1455E-01	.432567	-.080234	.448526	.0709	.80	.7792E+04	.1134E+03
61	61	0	.1926E-01	.495258	.106202	.516383	.0709	1.29	.1248E+05	.2404E+03
62	62	0	.2554E-01	.483831	.333639	.599164	.0709	1.97	.1909E+05	.4952E+03
63	63	0	.3364E-01	.365157	.559922	.681524	.0709	2.70	.2618E+05	.8806E+03
64	64	0	.3928E-01	.137720	.708041	.735435	.0709	3.19	.3095E+05	.1216E+04
65	65	0	.1031E-01	.077502	-.385516	.400932	.0233	0.00	0.	0.
66	66	0	.1118E-01	.229694	-.339298	.417754	.0233	0.00	0.	0.
67	67	0	.1312E-01	.371649	-.243094	.452770	.0233	0.00	0.	0.
68	68	0	.1649E-01	.490082	-.090902	.508163	.0233	0.00	0.	0.
69	69	0	.2183E-01	.561109	.120323	.585043	.0233	.33	.3199E+04	.6985E+02
70	70	0	.2940E-01	.548162	.378001	.678030	.0233	1.16	.1123E+05	.3302E+03
71	71	0	.3813E-01	.413709	.634371	.772141	.0233	2.38	.2307E+05	.8797E+03
72	72	0	.4452E-01	.156031	.802183	.833220	.0233	3.39	.3290E+05	.1465E+04

FX = 0. FD = .1900820E+05 FN = .1329214E+05 SMX = .1598109E+05 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = 1.7327569 CN = 1.2116900 MX = 1.2140083 MY = 0.0000000 MZ = 0.0000000

EXAMPLE 3

*******PROGRAM OPTIONS*******
VARIABLE BODY ORIENTATION
DONT PRINT
SYMMETRIC CONFIGURATION

*******PROBLEM PARAMETERS*******
DIAMETER 1.0000 FT
ENTRY VELOCITY 50.000(FT/SEC)
BODY ORIENTATION ANGLE 90.00 DEGREES
INITIAL DEPTH 0.00000 FT TERMINATION STEP 18
INITIAL PRESSURE CORRECTION FACTOR = .6760
CENTROIDE COORDINATES 0.00000 0.00000 0.00000

NO	VX	VY	VZ	WX	CWT	H
1	0.0000	0.0000	-50.0000	0.0	1.262200	.050001
2	0.0000	0.0000	-50.0000	0.0	1.252000	.050000
3	0.0000	0.0000	-50.0000	0.0	1.232900	.050000
4	0.0000	0.0000	-50.0000	0.0	1.224200	.050000
5	0.0000	0.0000	-50.0000	0.0	1.207500	.050000
6	0.0000	0.0000	-50.0000	0.0	1.199500	.050000
7	0.0000	0.0000	-50.0000	0.0	1.183000	.050000
8	0.0000	0.0000	-50.0000	0.0	1.176100	.050000
9	0.0000	0.0000	-50.0000	0.0	1.160700	.050000
10	0.0000	0.0000	-50.0000	0.0	1.153000	.050000
11	0.0000	0.0000	-50.0000	0.0	1.137700	.050000
12	0.0000	0.0000	-50.0000	0.0	1.130600	.050000
13	0.0000	0.0000	-50.0000	0.0	1.114107	.050000
14	0.0000	0.0000	-50.0000	0.0	1.106000	.050000
15	0.0000	0.0000	-50.0000	0.0	1.089500	.050000
16	0.0000	0.0000	-50.0000	0.0	1.081100	.050000
17	0.0000	0.0000	-50.0000	0.0	1.067100	.050000
18	0.0000	0.0000	-50.0000	0.0	1.061500	.050000

*******GRID OPTIONS*******
STANDARD

GRID SIZE

R	Z	NUMBER
.000100	0.000000	8
.112400	.100000	8
.203500	.200000	8
.278500	.300000	8
.340400	.400000	6
.391300	.500000	6
.432300	.600000	6
.464500	.700000	8
.488500	.800000	8
.500000	.870000	8

NODE	X	Y	Z	XP	YP	ZP
1	0.0000	-.0001	0.0000	0.0000	-.0001	-.0000
2	.0001	-.0000	0.0000	.0001	-.0009	-.0006
3	.0001	.0001	0.0000	.0001	.0001	.0006
4	-.0006	.0001	0.0000	-.0000	.0001	.0000
5	0.0000	-.0001	0.0000	0.0000	-.0001	-.0000
6	.0000	-.0001	0.0000	.0000	-.0001	-.0000
7	.0001	-.0001	0.0000	.0001	-.0001	-.0000
8	.0001	-.0000	0.0000	.0001	-.0006	-.0006
9	.0001	.0000	0.0006	.0001	.0006	.0000
10	.0001	.0000	0.0000	.0001	.0000	.0000
11	.0001	.0001	0.0000	.0001	.0001	.0000
12						

12	[illegible]	.0001	[illegible]	[illegible]	.0001	.0000
13	-.0000	.0001	0.0000	-.0000	.0001	.0000
14	0.0000	-.1124	.1000	0.0000	-.1124	.1000
15	.0430	-.1038	.1000	.0430	-.1038	.1000
16	.0795	-.0795	.1000	.0795	-.0795	.1000
17	.1038	-.0430	.1000	.1038	-.0430	.1000
18	.1124	.0000	.1000	.1124	.0000	.1000
19	.1038	.0430	.1000	.1038	.0430	.1000
20	.0795	.0795	.1000	.0795	.0795	.1000
21	.0430	.1038	.1000	.0430	.1038	.1000
22	-.0000	.1124	.1000	-.0000	.1124	.1000
23	0.0000	-.2035	.2000	0.0000	-.2035	.2000
24	.0779	-.1880	.2000	.0779	-.1880	.2000
25	.1439	-.1439	.2000	.1439	-.1439	.2000
26	.1880	-.0779	.2000	.1880	-.0779	.2000
27	.2035	.0000	.2000	.2035	.0000	.2000
28	.1880	.0779	.2000	.1880	.0779	.2000
29	.1439	.1439	.2000	.1439	.1439	.2000
30	.0779	.1880	.2000	.0779	.1880	.2000
31	-.0000	.2035	.2000	-.0000	.2035	.2000
32	0.0000	-.2785	.3000	0.0000	-.2785	.3000
33	.1066	-.2573	.3000	.1066	-.2573	.3000
34	.1969	-.1969	.3000	.1969	-.1969	.3000
35	.2573	-.1066	.3000	.2573	-.1066	.3000
36	.2785	.0000	.3000	.2785	-.0000	.3000
37	.2573	.1066	.3000	.2573	.1066	.3000
38	.1969	.1969	.3000	.1969	.1969	.3000
39	.1066	.2573	.3000	.1066	.2573	.3000
40	-.0000	.2785	.3000	-.0000	.2785	.3000
41	0.0000	-.3404	.4000	0.0000	-.3404	.4000
42	.1303	-.3145	.4000	.1303	-.3145	.4000
43	.2407	-.2407	.4000	.2407	-.2407	.4000
44	.3145	-.1303	.4000	.3145	-.1303	.4000
45	.3404	.0000	.4000	.3404	-.0000	.4000
46	.3145	.1303	.4000	.3145	.1303	.4000
47	.2407	.2407	.4000	.2407	.2407	.4000
48	.1303	.3145	.4000	.1303	.3145	.4000
49	-.0000	.3404	.4000	-.0000	.3404	.4000
50	0.0000	-.3913	.5000	0.0000	-.3913	.5000
51	.1497	-.3615	.5000	.1497	-.3615	.5000
52	.2767	-.2767	.5000	.2767	-.2767	.5000
53	.3615	-.1497	.5000	.3615	-.1497	.5000
54	.3913	.0000	.5000	.3913	-.0000	.5000
55	.3615	.1497	.5000	.3615	.1497	.5000
56	.2767	.2767	.5000	.2767	.2767	.5000
57	.1497	.3615	.5000	.1497	.3615	.5000
58	-.0000	.3913	.5000	-.0000	.3913	.5000
59	0.0000	-.4323	.6000	0.0000	-.4323	.6000
60	.1654	-.3994	.6000	.1654	-.3994	.6000
61	.3057	-.3057	.6000	.3057	-.3057	.6000
62	.3994	-.1654	.6000	.3994	-.1654	.6000
63	.4323	.0000	.6000	.4323	-.0000	.6000
64	.3994	.1654	.6000	.3994	.1654	.6000
65	.3057	.3057	.6000	.3057	.3057	.6000
66	.1654	.3994	.6000	.1654	.3994	.6000
67	-.0000	.4323	.6000	-.0000	.4323	.6000
68	0.0000	-.4645	.7000	0.0000	-.4645	.7000
69	.1778	-.4291	.7000	.1778	-.4291	.7000
70	.3285	-.3285	.7000	.3285	-.3285	.7000
71	.4291	-.1778	.7000	.4291	-.1778	.7000
72	.4645	.0000	.7000	.4645	-.0000	.7000
73	.4291	.1778	.7000	.4291	.1778	.7000
74	.3285	.3285	.7000	.3285	.3285	.7000
75	.1778	.4291	.7000	.1778	.4291	.7000
76	-.0000	.4645	.7000	-.0000	.4645	.7000
77	0.0000	-.4885	.8000	0.0000	-.4885	.8000
78	.1869	-.4513	.8000	.1869	-.4513	.8000

79	.3454	-.3454	.8000	.3454	-.3454	.8000
80	.4513	-.1869	.8000	.4513	-.1869	.8000
81	.4885	.0000	.8000	.4885	-.0000	.8000
82	.4513	.1869	.8000	.4513	.1869	.8000
83	.3454	.3454	.8000	.3454	.3454	.8000
84	.1869	.4513	.8000	.1869	.4513	.8000
85	-.0000	.4885	.8000	-.0000	.4885	.8000
86	0.0000	-.5000	.8700	0.0000	-.5000	.8700
87	.1913	-.4619	.8700	.1913	-.4619	.8700
88	.3536	-.3536	.8700	.3536	-.3536	.8700
89	.4619	-.1913	.8700	.4619	-.1913	.8700
90	.5000	.0000	.8700	.5000	-.0000	.8700
91	.4619	.1913	.8700	.4619	.1913	.8700
92	.3536	.3536	.8700	.3536	.3536	.8700
93	.1913	.4619	.8700	.1913	.4619	.8700
94	-.0000	.5000	.8700	-.0000	.5000	.8700

ELEMENT	1	2	3	4	XC	YC	ZC	RC	TC	AREA
1	14	15	6	5	.01434	-.07208	.06664	.07349	168.750	.3265E-02
2	15	16	7	6	.04083	-.06111	.06664	.07349	146.250	.3265E-02
3	16	17	8	7	.06111	-.04083	.06664	.07349	123.750	.3265E-02
4	17	18	9	8	.07208	-.01434	.06664	.07349	101.250	.3265E-02
5	18	19	10	9	.07208	.01434	.06664	.07349	78.750	.3265E-02
6	19	20	11	10	.06111	.04083	.06664	.07349	56.250	.3265E-02
7	20	21	12	11	.04083	.06111	.06664	.07349	33.750	.3265E-02
8	21	22	13	12	.01434	.07208	.06664	.07349	11.250	.3265E-02
9	23	24	15	14	.03106	-.15615	.15481	.15921	168.750	.8265E-02
10	24	25	16	15	.08845	-.13238	.15481	.15921	146.250	.8265E-02
11	25	26	17	16	.13238	-.08845	.15481	.15921	123.750	.8265E-02
12	26	27	18	17	.15615	-.03106	.15481	.15921	101.250	.8265E-02
13	27	28	19	18	.15615	.03106	.15481	.15921	78.750	.8265E-02
14	28	29	20	19	.13238	.08845	.15481	.15921	56.250	.8265E-02
15	29	30	21	20	.08845	.13238	.15481	.15921	33.750	.8265E-02
16	30	31	22	21	.03106	.15615	.15481	.15921	11.250	.8265E-02
17	32	33	24	23	.04649	-.23370	.25259	.23828	168.750	.1167E-01
18	33	34	25	24	.13238	-.19812	.25259	.23828	146.250	.1167E-01
19	34	35	26	25	.19812	-.13238	.25259	.23828	123.750	.1167E-01
20	35	36	27	26	.23370	-.04649	.25259	.23828	101.250	.1167E-01
21	36	37	28	27	.23370	.04649	.25259	.23828	78.750	.1167E-01
22	37	38	29	28	.19812	.13238	.25259	.23828	56.250	.1167E-01
23	38	39	30	29	.13238	.19812	.25259	.23828	33.750	.1167E-01
24	39	40	31	30	.04649	.23370	.25259	.23828	11.250	.1167E-01
25	41	42	33	32	.05941	-.29866	.35167	.30452	168.750	.1413E-01
26	42	43	34	33	.16918	-.25320	.35167	.30452	146.250	.1413E-01
27	43	44	35	34	.25320	-.16918	.35167	.30452	123.750	.1413E-01
28	44	45	36	35	.29866	-.05941	.35167	.30452	101.250	.1413E-01
29	45	46	37	36	.29866	.05941	.35167	.30452	78.750	.1413E-01
30	46	47	38	37	.25320	.16918	.35167	.30452	56.250	.1413E-01
31	47	48	39	38	.16918	.25320	.35157	.30452	33.750	.1413E-01
32	48	49	40	39	.05941	.29866	.35167	.30452	11.250	.1413E-01
33	50	51	42	41	.07012	-.35249	.45116	.35940	168.750	.1595E-01
34	51	52	43	42	.19967	-.29883	.45116	.35940	146.250	.1595E-01
35	52	53	44	43	.29883	-.19967	.45116	.35940	123.750	.1595E-01
36	53	54	45	44	.35249	-.07012	.45116	.35940	101.250	.1595E-01
37	54	55	46	45	.35249	.07012	.45116	.35940	78.750	.1595E-01
38	55	56	47	46	.29883	.19967	.45116	.35940	56.250	.1595E-01
39	56	57	48	47	.19967	.29883	.45116	.35940	33.750	.1595E-01
40	57	58	49	48	.07012	.35249	.45116	.35940	11.250	.1595E-01
41	59	60	51	50	.07886	-.39645	.55083	.40422	168.750	.1732E-01
42	60	61	52	51	.22457	-.33610	.55083	.40422	146.250	.1732E-01
43	61	62	53	52	.33610	-.22457	.55083	.40422	123.750	.1732E-01
44	62	63	54	53	.39645	-.07886	.55083	.40422	101.250	.1732E-01
45	63	64	55	54	.39645	.07886	.55083	.40422	78.750	.1732E-01
46	64	65	56	55	.33610	.22457	.55083	.40422	56.250	.1732E-01
47	65	66	57	56	.22457	.33610	.55083	.40422	33.750	.1732E-01

48	66	67	58	57	.07886	.39645	.55083	.40422	11.250	.1732E-01
49	68	69	60	59	.08583	-.43152	.65060	.43997	166.750	.1835E-01
50	69	70	61	60	.24444	-.36582	.65060	.43997	146.250	.1835E-01
51	70	71	62	61	.36582	-.24444	.65060	.43997	123.750	.1835E-01
52	71	72	63	62	.43152	-.08583	.65060	.43997	101.250	.1835E-01
53	72	73	64	63	.43152	.08583	.65060	.43997	78.750	.1835E-01
54	73	74	65	64	.36582	.24444	.65060	.43997	56.250	.1835E-01
55	74	75	66	65	.24444	.36582	.65060	.43997	33.750	.1835E-01
56	75	76	67	66	.08583	.43152	.65060	.43997	11.250	.1835E-01
57	77	78	69	68	.09119	-.45846	.75042	.46744	168.750	.1910E-01
58	78	79	70	69	.25970	-.38866	.75042	.46744	146.250	.1910E-01
59	79	80	71	70	.38866	-.25970	.75042	.46744	123.750	.1910E-01
60	80	81	72	71	.45846	-.09119	.75042	.46744	101.250	.1910E-01
61	81	82	73	72	.45846	.09119	.75042	.46744	78.750	.1910E-01
62	82	83	74	73	.38866	.25970	.75042	.46744	56.250	.1910E-01
63	83	84	75	74	.25970	.38866	.75042	.46744	33.750	.1910E-01
64	84	85	76	75	.09119	.45846	.75042	.46744	11.250	.1910E-01
65	86	87	78	77	.09457	-.47546	.83514	.48477	168.750	.1367E-01
66	87	88	79	78	.26933	-.40308	.83514	.48477	146.250	.1367E-01
67	88	89	80	79	.40308	-.26933	.83514	.48477	123.750	.1367E-01
68	89	90	81	80	.47546	-.09457	.83514	.48477	101.250	.1367E-01
69	90	91	82	81	.47546	.09457	.83514	.48477	78.750	.1367E-01
70	91	92	83	82	.40308	.26933	.83514	.48477	56.250	.1367E-01
71	92	93	84	83	.26933	.40308	.83514	.48477	33.750	.1367E-01
72	93	94	85	84	.09457	.47546	.83514	.48477	11.250	.1367E-01

STEP 1 COMPLETE.CP TIME FOR STEP IS 1.23300

STEP 2 COMPLETE.CP TIME FOR STEP IS 1.33900

STEP 3 COMPLETE.CP TIME FOR STEP IS 3.72800

STEP 4 COMPLETE.CP TIME FOR STEP IS 4.10600

STEP 5 COMPLETE.CP TIME FOR STEP IS 7.19100

STEP 6 COMPLETE.CP TIME FOR STEP IS 6.76600

STEP 7 COMPLETE.CP TIME FOR STEP IS 9.97300

STEP 8 COMPLETE.CP TIME FOR STEP IS 9.79300

STEP 9 COMPLETE.CP TIME FOR STEP IS 13.20100

STEP 10 COMPLETE.CP TIME FOR STEP IS 12.70700

STEP 11 COMPLETE.CP TIME FOR STEP IS 16.56500

STEP 12 COMPLETE.CP TIME FOR STEP IS 16.00300

STEP 13 COMPLETE.CP TIME FOR STEP IS 19.98400

STEP 14 COMPLETE.CP TIME FOR STEP IS 26.17900

STEP 15 COMPLETE.CP TIME FOR STEP IS 24.38400

STEP 16 COMPLETE.CP TIME FOR STEP IS 24.06500

STEP 17 COMPLETE.CP TIME FOR STEP IS 28.82900

STEP 18 COMPLETE.CP TIME FOR STEP IS 28.16300

STEP 1 DEPTH = .0560010 TIME = .0007923 DIMENSIONLESS TIME .0396142 WETTING FACTORS = 1.2622000 1.2520000
AVERAGE VELOCITY 0.000 0.000 -50.000 WE 4.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	1	.8177E-03	.007175	-.036874	.033304	.0132	1.78	.4326E+04	.3538E+01
2	2	1	.8177E-03	.020434	-.030582	.033304	.0132	1.78	.4326E+04	.3538E+01
3	3	1	.8177E-03	.030582	-.020434	.033304	.0132	1.78	.4326E+04	.3538E+01
4	4	1	.8177E-03	.036874	-.007175	.033304	.0132	1.78	.4326E+04	.3538E+01
5	5	1	.8177E-03	.036874	.007175	.033304	.0132	1.78	.4326E+04	.3538E+01
6	6	1	.8177E-03	.030582	.020434	.033304	.0132	1.78	.4326E+04	.3538E+01
7	7	1	.8177E-03	.020434	.030582	.033304	.0132	1.78	.4326E+04	.3538E+01
8	8	1	.8177E-03	.007175	.036874	.033304	.0132	1.78	.4326E+04	.3538E+01

FX = 0. FD = .4198940E+02 FN = .2753865E-08 SMX = -.1917897E-09 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .0220656 CN = .0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 2 DEPTH = .1600010 TIME = .0015910 DIMENSIONLESS TIME .0795503 WETTING FACTORS = 1.2520000 1.2329060
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.0265	2.17	.5264E+04	.1719E+02
2	2	0	.3265E-02	.040831	-.061108	.066637	.0265	2.17	.5264E+04	.1719E+02
3	3	0	.3265E-02	.061108	-.040831	.066637	.0265	2.17	.5264E+04	.1719E+02
4	4	0	.3265E-02	.072081	-.014338	.066637	.0265	2.17	.5264E+04	.1719E+02
5	5	0	.3265E-02	.072081	.014338	.066637	.0265	2.17	.5264E+04	.1719E+02
6	6	0	.3265E-02	.061108	.040831	.066637	.0265	2.17	.5264E+04	.1719E+02
7	7	0	.3265E-02	.040831	.061108	.066637	.0265	2.17	.5264E+04	.1719E+02
8	8	0	.3265E-02	.014338	.072081	.066637	.0265	2.17	.5264E+04	.1719E+02

FX = 0. FD = .2036190E+03 FN = .3667064E-07 SMX = .3168473E-08 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .1069147 CN = .0000000 MX = .0000000 MY = 0.0000000 MZ = 0.0000000

STEP 3 DEPTH = .1500010 TIME = .0024021 DIMENSIONLESS TIME .1201051 WETTING FACTORS = 1.2329000 1.2242000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.0671	1.27	.3072E+04	.1003E+02
2	2	0	.3265E-02	.040831	-.061108	.066637	.0671	1.27	.3072E+04	.1003E+02
3	3	0	.3265E-02	.061108	-.040831	.066637	.0671	1.27	.3072E+04	.1003E+02
4	4	0	.3265E-02	.072081	-.014338	.066637	.0671	1.27	.3072E+04	.1003E+02
5	5	0	.3265E-02	.072081	.014338	.066637	.0671	1.27	.3072E+04	.1003E+02
6	6	0	.3265E-02	.061108	.040831	.066637	.0671	1.27	.3072E+04	.1003E+02
7	7	0	.3265E-02	.040831	.061108	.066637	.0671	1.27	.3072E+04	.1003E+02
8	8	0	.3265E-02	.014338	.072081	.066637	.0671	1.27	.3072E+04	.1003E+02
9	9	1	.3537E-02	.026109	-.131261	.126405	.0191	1.20	.2906E+04	.1028E+02
10	10	1	.3537E-02	.074353	-.111276	.126405	.0191	1.20	.2906E+04	.1028E+02
11	11	1	.3537E-02	.111278	-.074353	.126405	.0191	1.20	.2906E+04	.1028E+02
12	12	1	.3537E-02	.131261	-.026109	.126405	.0191	1.20	.2906E+04	.1028E+02
13	13	1	.3537E-02	.131261	.026109	.126405	.0191	1.20	.2906E+04	.1028E+02
14	14	1	.3537E-02	.111278	.074353	.126405	.0191	1.20	.2906E+04	.1028E+02
15	15	1	.3537E-02	.074353	.111278	.126405	.0191	1.20	.2906E+04	.1028E+02
16	16	1	.3537E-02	.026109	.131261	.126405	.0191	1.20	.2906E+04	.1028E+02

FX = 0. FD = .2283642E+03 FN = -.8061290E-09 SMX = -.5660864E-06 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .1199098 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 4 DEPTH = .2000010 TIME = .0032190 DIMENSIONLESS TIME .1609+01 WETTING FACTORS = 1.2242000 1.2075000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.1074	1.21	.2926E+04	.9554E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.1073	1.21	.2926E+04	.9554E+01

3	3	0	.3265E-02	.061108	-.040831	.066637	.1079	1.21	.2926E+04	.9554E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.1079	1.21	.2926E+04	.9554E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.1079	1.21	.2926E+04	.9554E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.1079	1.21	.2926E+04	.9554E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.1079	1.21	.2926E+04	.9554E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.1079	1.21	.2926E+04	.9554E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.0368	1.18	.2868E+04	.2371E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.0368	1.18	.2868E+04	.2371E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.0368	1.18	.2868E+04	.2371E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.0368	1.18	.2868E+04	.2371E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.0368	1.18	.2868E+04	.2371E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.0368	1.18	.2868E+04	.2371E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.0368	1.18	.2868E+04	.2371E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.0368	1.18	.2868E+04	.2371E+02

FX = 0. FD = .3658917E+03 FN = .3926015E-07 SMX = .2327482E-08 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .1921196 CN = .0000000 MX = .0000000 MY = 0.0000000 MZ = 0.0000000

STEP 5 DEPTH = .2500010 TIME = .0040471 DIMENSIONLESS TIME .2023559 WETTING FACTORS = 1.2075000 1.1995000
AVERAGE VELOCITY 0.000 0.000 -60.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.1493	1.10	.2669E+04	.8715E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.1493	1.10	.2669E+04	.8715E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.1493	1.10	.2669E+04	.8715E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.1493	1.10	.2669E+04	.8715E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.1493	1.10	.2669E+04	.8715E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.1493	1.10	.2669E+04	.8715E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.1493	1.10	.2669E+04	.8715E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.1493	1.10	.2669E+04	.8715E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.0782	.95	.2294E+04	.1896E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.0782	.95	.2294E+04	.1896E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.0782	.95	.2294E+04	.1896E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.0782	.95	.2294E+04	.1896E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.0782	.95	.2294E+04	.1896E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.0782	.95	.2294E+04	.1896E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.0782	.95	.2294E+04	.1896E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.0782	.95	.2294E+04	.1896E+02
17	17	1	.5383E-02	.042627	-.214299	.225704	.0201	.79	.1905E+04	.1026E+02
18	18	1	.5383E-02	.121390	-.181674	.225704	.0201	.79	.1905E+04	.1026E+02
19	19	1	.5383E-02	.181674	-.121390	.225704	.0201	.79	.1905E+04	.1026E+02
20	20	1	.5383E-02	.214299	-.042627	.225704	.0201	.79	.1905E+04	.1026E+02
21	21	1	.5383E-02	.214299	.042627	.225704	.0201	.79	.1905E+04	.1026E+02
22	22	1	.5383E-02	.181674	.121390	.225704	.0201	.79	.1905E+04	.1026E+02
23	23	1	.5383E-02	.121390	.181674	.225704	.0201	.79	.1905E+04	.1026E+02
24	24	1	.5383E-02	.042627	.214299	.225704	.0201	.79	.1905E+04	.1026E+02

FX = 0. FD = .4026207E+03 FN = -.1658361E-07 SMX = -.1957196E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2114049 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 6 DEPTH = .3000010 TIME = .0048808 DIMENSIONLESS TIME .2440400 WETTING FACTORS = 1.1995000 1.1838000
AVERAGE VELOCITY 0.000 0.000 -60.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.1910	1.07	.2607E+04	.8510E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.1910	1.07	.2607E+04	.8510E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.1910	1.07	.2607E+04	.8510E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.1910	1.07	.2607E+04	.8510E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.1910	1.07	.2607E+04	.8510E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.1910	1.07	.2607E+04	.8510E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.1910	1.07	.2607E+04	.8510E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.1910	1.07	.2607E+04	.8510E+01

9	9	0	.3265E-02	.031060	-.156150	.154806	.1199	.89	.2166E+04	.1790E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.1199	.89	.2166E+04	.1790E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.1199	.89	.2166E+04	.1790E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.1199	.89	.2166E+04	.1790E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.1199	.89	.2166E+04	.1790E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.1199	.89	.2166E+04	.1790E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.1199	.89	.2166E+04	.1790E+02
16	16	0	.3265E-02	.031060	.156150	.154806	.1199	.89	.2166E+04	.1790E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.0394	.71	.1714E+04	.2001E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.0394	.71	.1714E+04	.2001E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.0394	.71	.1714E+04	.2001E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.0394	.71	.1714E+04	.2001E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.0394	.71	.1714E+04	.2001E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.0394	.71	.1714E+04	.2001E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.0394	.71	.1714E+04	.2001E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.0394	.71	.1714E+04	.2001E+02

FX = 0. FD = .4813580E+03 FN = .1800777F-07 SMX = -.9190359F-08 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2527477 CN = .0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 7 DEPTH = .3500010 TIME = .0057255 DIMENSIONLESS TIME .2862760 WETTING FACTORS = 1.1838000 1.1761000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOC	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.2333	1.03	.2493E+04	.8140E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.2333	1.03	.2493E+04	.8140E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.2333	1.03	.2493E+04	.8140E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.2333	1.03	.2493E+04	.8140E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.2333	1.03	.2493E+04	.8140E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.2333	1.03	.2493E+04	.8140E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.2333	1.03	.2493E+04	.8140E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.2333	1.03	.2493E+04	.8140E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.1621	.81	.1968E+04	.1627E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.1621	.81	.1968E+04	.1627E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.1621	.81	.1968E+04	.1627E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.1621	.81	.1968E+04	.1627E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.1621	.81	.1968E+04	.1627E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.1621	.81	.1968E+04	.1627E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.1621	.81	.1968E+04	.1627E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.1621	.81	.1968E+04	.1627E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.0816	.65	.1577E+04	.1841E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.0816	.65	.1577E+04	.1841E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.0816	.65	.1577E+04	.1841E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.0816	.65	.1577E+04	.1841E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.0816	.65	.1577E+04	.1841E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.0816	.65	.1577E+04	.1841E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.0816	.65	.1577E+04	.1841E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.0816	.65	.1577E+04	.1841E+02
25	25	1	.6709E-02	.056302	-.283048	.325439	.0207	.44	.1072E+04	.7194E+01
26	26	1	.6709E-02	.160334	-.239956	.325439	.0207	.44	.1072E+04	.7194E+01
27	27	1	.6709E-02	.239956	-.160334	.325439	.0207	.44	.1072E+04	.7194E+01
28	28	1	.6709E-02	.283048	-.056302	.325439	.0207	.44	.1072E+04	.7194E+01
29	29	1	.6709E-02	.283048	.056302	.325439	.0207	.44	.1072E+04	.7194E+01
30	30	1	.6709E-02	.239956	.160334	.325439	.0207	.44	.1072E+04	.7194E+01
31	31	1	.6709E-02	.160334	.239956	.325439	.0207	.44	.1072E+04	.7194E+01
32	32	1	.6709E-02	.056302	.283048	.325439	.0207	.44	.1072E+04	.7194E+01

FX = 0. FD = .5040094E+03 FN = -.4645934F-07 SMX = -.3900821F-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2646786 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 8 DEPTH = .4000010 TIME = .0065758 DIMENSIONLESS TIME .3287902 WETTING FACTORS = 1.1761000 1.1607000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.2758	1.00	.2428E+04	.7928E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.2758	1.00	.2428E+04	.7928E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.2758	1.00	.2428E+04	.7928E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.2758	1.00	.2428E+04	.7928E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.2758	1.00	.2428E+04	.7928E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.2758	1.00	.2428E+04	.7928E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.2758	1.00	.2428E+04	.7928E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.2758	1.00	.2428E+04	.7928E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.2046	.79	.1904E+04	.1573E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.2046	.79	.1904E+04	.1573E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.2046	.79	.1904E+04	.1573E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.2046	.79	.1904E+04	.1573E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.2046	.79	.1904E+04	.1573E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.2046	.79	.1904E+04	.1573E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.2046	.79	.1904E+04	.1573E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.2046	.79	.1904E+04	.1573E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.1241	.61	.1488E+04	.1737E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.1241	.61	.1488E+04	.1737E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.1241	.61	.1488E+04	.1737E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.1241	.61	.1488E+04	.1737E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.1241	.61	.1488E+04	.1737E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.1241	.61	.1488E+04	.1737E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.1241	.61	.1488E+04	.1737E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.1241	.61	.1488E+04	.1737E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.0410	.35	.8571E+03	.1211E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.0410	.35	.8571E+03	.1211E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.0410	.35	.8571E+03	.1211E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.0410	.35	.8571E+03	.1211E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.0410	.35	.8571E+03	.1211E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.0410	.35	.8571E+03	.1211E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.0410	.35	.8571E+03	.1211E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.0410	.35	.8571E+03	.1211E+02

FX = 0. FD = .5768074E+03 FN = -.2329455E-07 SMX = -.3351587E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2766119 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 9 DEPTH = .4500010 TIME = .0074374 DIMENSIONLESS TIME .3718677 WETTING FACTORS = 1.1607000 1.1530000
AVERAGE VELOCITY 0.000 0.000 -56.000 WX 0.000RIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.3189	.97	.2347E+04	.7662E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.3189	.97	.2347E+04	.7662E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.3189	.97	.2347E+04	.7662E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.3189	.97	.2347E+04	.7662E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.3189	.97	.2347E+04	.7662E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.3189	.97	.2347E+04	.7662E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.3189	.97	.2347E+04	.7662E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.3189	.97	.2347E+04	.7662E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.2477	.75	.1810E+04	.1496E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.2477	.75	.1810E+04	.1496E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.2477	.75	.1810E+04	.1496E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.2477	.75	.1810E+04	.1496E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.2477	.75	.1810E+04	.1496E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.2477	.75	.1810E+04	.1496E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.2477	.75	.1810E+04	.1496E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.2477	.75	.1810E+04	.1496E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.1672	.55	.1329E+04	.1551E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.1672	.55	.1329E+04	.1551E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.1672	.55	.1329E+04	.1551E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.1672	.55	.1329E+04	.1551E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.1672	.55	.1329E+04	.1551E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.1672	.55	.1329E+04	.1551E+02

23	23	0	.1167E-01	.132380	.198120	.252593	.1572	.55	.1329E+04	.1551E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.1672	.55	.1329E+04	.1551E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.0840	.39	.9403E+03	.1328E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.0840	.39	.9403E+03	.1328E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.0840	.39	.9403E+03	.1328E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.0840	.39	.9403E+03	.1328E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.0840	.39	.9403E+03	.1328E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.0840	.39	.9403E+03	.1328E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.0840	.39	.9403E+03	.1328E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.0840	.39	.9403E+03	.1328E+02
33	33	1	.7700E-02	.067597	-.339832	.425301	.0213	.19	.4659E+03	.3587E+01
34	34	1	.7700E-02	.192500	-.288096	.425301	.0213	.19	.4659E+03	.3587E+01
35	35	1	.7700E-02	.288096	-.192500	.425301	.0213	.19	.4659E+03	.3587E+01
36	36	1	.7700E-02	.339832	-.067597	.425301	.0213	.19	.4659E+03	.3587E+01
37	37	1	.7700E-02	.339832	.067597	.425301	.0213	.19	.4659E+03	.3587E+01
38	38	1	.7700E-02	.288096	.192500	.425301	.0213	.19	.4659E+03	.3587E+01
39	39	1	.7700E-02	.192500	.288096	.425301	.0213	.19	.4659E+03	.3587E+01
40	40	1	.7700E-02	.067597	.339832	.425301	.0213	.19	.4659E+03	.3587E+01

FX = 0. FD = .5331906E+03 FN = -.6872372F-07 SMX = -.6008700F-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2799583 CN = -.0000000 MX = -.0000300 MY = 0.0000000 MZ = 0.0000000

STEP 10 DEPTH = .5400010 TIME = .0043047 DIMENSIONLESS TIME .4152328 WETTING FACTORS = 1.1530000 1.1377000
AVERAGE VELOCITY 0.000 0.000 -50.060 WX 0.0 ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.3622	.94	.2288E+04	.7472E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.3622	.94	.2288E+04	.7472E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.3622	.94	.2288E+04	.7472E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.3622	.94	.2288E+04	.7472E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.3622	.94	.2288E+04	.7472E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.3622	.94	.2288E+04	.7472E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.3622	.94	.2288E+04	.7472E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.3622	.94	.2288E+04	.7472E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.2911	.72	.1753E+04	.1449E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.2911	.72	.1753E+04	.1449E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.2911	.72	.1753E+04	.1449E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.2911	.72	.1753E+04	.1449E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.2911	.72	.1753E+04	.1449E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.2911	.72	.1753E+04	.1449E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.2911	.72	.1753E+04	.1449E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.2911	.72	.1753E+04	.1449E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.2106	.52	.1271E+04	.1484E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.2106	.52	.1271E+04	.1484E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.2106	.52	.1271E+04	.1484E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.2106	.52	.1271E+04	.1484E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.2106	.52	.1271E+04	.1484E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.2106	.52	.1271E+04	.1484E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.2106	.52	.1271E+04	.1484E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.2106	.52	.1271E+04	.1484E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.1274	.37	.8908E+03	.1258E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.1274	.37	.8908E+03	.1258E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.1274	.37	.8908E+03	.1258E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.1274	.37	.8908E+03	.1258E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.1274	.37	.8908E+03	.1258E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.1274	.37	.8908E+03	.1258E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.1274	.37	.8908E+03	.1258E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.1274	.37	.8908E+03	.1258E+02
33	33	0	.1595E-01	.070115	-.352493	.451159	.0422	.10	.2439E+03	.3891E+01
34	34	0	.1595E-01	.199671	-.298629	.451159	.0422	.10	.2439E+03	.3891E+01
35	35	0	.1595E-01	.298629	-.199671	.451159	.0422	.10	.2439E+03	.3891E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.0422	.10	.2439E+03	.3891E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.0422	.10	.2439E+03	.3891E+01
38	38	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

39	39	0	.1595E-01	.199671	.298829	.451159	.0422	.10	.2439E+03	.3891E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.0422	.10	.2439E+03	.3891E+01

FX = 0. FD = .5159396E+03 FN = -.7234541E-07 SMX = -.6501867E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2704055 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 11 DEPTH = .5500010 TIME = .0091836 DIMENSIONLESS TIME .4591811 WETTING FACTORS = 1.1377000 1.1300000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	TS	CP	P	FORCE
1	1	0	.3265E-02	.014339	-.072081	.066637	.4062	.92	.2224E+04	.7263E+01
2	2	0	.3265E-02	.040431	-.061104	.066637	.4062	.92	.2224E+04	.7263E+01
3	3	0	.3265E-02	.061104	-.040431	.066637	.4062	.92	.2224E+04	.7263E+01
4	4	0	.3265E-02	.072081	-.014339	.066637	.4062	.92	.2224E+04	.7263E+01
5	5	0	.3265E-02	.072081	.014339	.066637	.4062	.92	.2224E+04	.7263E+01
6	6	0	.3265E-02	.061104	.040431	.066637	.4062	.92	.2224E+04	.7263E+01
7	7	0	.3265E-02	.040431	.061104	.066637	.4062	.92	.2224E+04	.7263E+01
8	8	0	.3265E-02	.014339	.072081	.066637	.4062	.92	.2224E+04	.7263E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.3350	.69	.1685E+04	.1393E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.3350	.69	.1685E+04	.1393E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.3350	.69	.1685E+04	.1393E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.3350	.69	.1685E+04	.1393E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.3350	.69	.1685E+04	.1393E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.3350	.69	.1685E+04	.1393E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.3350	.69	.1685E+04	.1393E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.3350	.69	.1685E+04	.1393E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.2545	.49	.1188E+04	.1387E+02
18	18	0	.1167E-01	.132390	-.198120	.252593	.2545	.49	.1188E+04	.1387E+02
19	19	0	.1167E-01	.198120	-.132390	.252593	.2545	.49	.1188E+04	.1387E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.2545	.49	.1188E+04	.1387E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.2545	.49	.1188E+04	.1387E+02
22	22	0	.1167E-01	.198120	.132390	.252593	.2545	.49	.1188E+04	.1387E+02
23	23	0	.1167E-01	.132390	.198120	.252593	.2545	.49	.1188E+04	.1387E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.2545	.49	.1188E+04	.1387E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.1714	.32	.7659E+03	.1082E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.1714	.32	.7659E+03	.1082E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.1714	.32	.7659E+03	.1082E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.1714	.32	.7659E+03	.1082E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.1714	.32	.7659E+03	.1082E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.1714	.32	.7659E+03	.1082E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.1714	.32	.7659E+03	.1082E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.1714	.32	.7659E+03	.1082E+02
33	33	0	.1595E-01	.070115	-.352493	.451159	.0862	.17	.4170E+03	.6654E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.0862	.17	.4170E+03	.6654E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.0862	.17	.4170E+03	.6654E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.0862	.17	.4170E+03	.6654E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.0862	.17	.4170E+03	.6654E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.0862	.17	.4170E+03	.6654E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.0862	.17	.4170E+03	.6654E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.0862	.17	.4170E+03	.6654E+01
41	41	1	.8444E-02	.076850	-.386351	.525213	.0218	.02	.4795E+02	.4049E+00
42	42	1	.8444E-02	.218850	-.327533	.525213	.0218	.02	.4795E+02	.4049E+00
43	43	1	.8444E-02	.327533	-.218850	.525213	.0218	.02	.4795E+02	.4049E+00
44	44	1	.8444E-02	.386351	-.076850	.525213	.0218	.02	.4795E+02	.4049E+00
45	45	1	.8444E-02	.386351	.076850	.525213	.0218	.02	.4795E+02	.4049E+00
46	46	1	.8444E-02	.327533	.218850	.525213	.0218	.02	.4795E+02	.4049E+00
47	47	1	.8444E-02	.218850	.327533	.525213	.0218	.02	.4795E+02	.4049E+00
48	48	1	.8444E-02	.076850	.386351	.525213	.0218	.02	.4795E+02	.4049E+00

FX = 0. FD = .5058057E+03 FN = -.9600806E-07 SMX = -.8159410E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2655847 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 12 DEPTH = .6000010 TIME = .0100646 DIMENSIONLESS TIME .5634289 WETTING FACTORS = 1.1300000 1.1141000
AVERAGE VELOCITY 0.000 0.000 -60.000 WX 0.000 ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.4504	.90	.2174E+04	.7099E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.4504	.90	.2174E+04	.7099E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.4504	.90	.2174E+04	.7099E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.4504	.90	.2174E+04	.7099E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.4504	.90	.2174E+04	.7099E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.4504	.90	.2174E+04	.7099E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.4504	.90	.2174E+04	.7099E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.4504	.90	.2174E+04	.7099E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.3793	.67	.1636E+04	.1352E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.3793	.67	.1636E+04	.1352E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.3793	.67	.1636E+04	.1352E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.3793	.67	.1636E+04	.1352E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.3793	.67	.1636E+04	.1352E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.3793	.67	.1636E+04	.1352E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.3793	.67	.1636E+04	.1352E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.3793	.67	.1636E+04	.1352E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.2988	.47	.1138E+04	.1329E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.2988	.47	.1138E+04	.1329E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.2988	.47	.1138E+04	.1329E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.2988	.47	.1138E+04	.1329E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.2988	.47	.1138E+04	.1329E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.2988	.47	.1138E+04	.1329E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.2988	.47	.1138E+04	.1329E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.2988	.47	.1138E+04	.1329E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.2156	.30	.7170E+03	.1013E+02
26	26	0	.1413E-01	.169180	-.253196	.351667	.2156	.30	.7170E+03	.1013E+02
27	27	0	.1413E-01	.253196	-.169180	.351667	.2156	.30	.7170E+03	.1013E+02
28	28	0	.1413E-01	.298665	-.059408	.351667	.2156	.30	.7170E+03	.1013E+02
29	29	0	.1413E-01	.298665	.059408	.351667	.2156	.30	.7170E+03	.1013E+02
30	30	0	.1413E-01	.253196	.169180	.351667	.2156	.30	.7170E+03	.1013E+02
31	31	0	.1413E-01	.169180	.253196	.351667	.2156	.30	.7170E+03	.1013E+02
32	32	0	.1413E-01	.059408	.298665	.351667	.2156	.30	.7170E+03	.1013E+02
33	33	0	.1595E-01	.070115	-.352493	.451159	.1304	.16	.3908E+03	.6235E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.1304	.16	.3908E+03	.6235E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.1304	.16	.3908E+03	.6235E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.1304	.16	.3908E+03	.6235E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.1304	.16	.3908E+03	.6235E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.1304	.16	.3908E+03	.6235E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.1304	.16	.3908E+03	.6235E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.1304	.16	.3908E+03	.6235E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.0434	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.0434	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.0434	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.0434	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.0434	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.0434	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.0434	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.0434	0.00	0.	0.

FX = 0. FD = .4628733E+03 FN = -.3944123E-07 SMX = -.4272517E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2535434 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 13 DEPTH = .6500010 TIME = .0109652 DIMENSIONLESS TIME .5683082 WETTING FACTORS = 1.1141000 1.1060000
AVERAGE VELOCITY 0.000 0.000 -60.000 WX 0.000 ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.4953	.88	.2123E+04	.6931E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.4953	.88	.2123E+04	.6931E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.4953	.88	.2123E+04	.6931E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.4953	.88	.2123E+04	.6931E+01

5	5	0	.3265E-02	.072081	.014338	.066637	.4953	.88	.2123E+04	.6931E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.4953	.88	.2123E+04	.6931E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.4953	.88	.2123E+04	.6931E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.4953	.88	.2123E+04	.6931E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.4241	.65	.1584E+04	.1309E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.4241	.65	.1584E+04	.1309E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.4241	.65	.1584E+04	.1309E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.4241	.65	.1584E+04	.1309E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.4241	.65	.1584E+04	.1309E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.4241	.65	.1584E+04	.1309E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.4241	.65	.1584E+04	.1309E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.4241	.65	.1584E+04	.1309E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.3437	.45	.1080E+04	.1260E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.3437	.45	.1080E+04	.1260E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.3437	.45	.1080E+04	.1260E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.3437	.45	.1080E+04	.1260E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.3437	.45	.1080E+04	.1260E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.3437	.45	.1080E+04	.1260E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.3437	.45	.1080E+04	.1260E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.3437	.45	.1080E+04	.1260E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.2605	.27	.6477E+03	.9148E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.2605	.27	.6477E+03	.9148E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.2605	.27	.6477E+03	.9148E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.2605	.27	.6477E+03	.9148E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.2605	.27	.6477E+03	.9148E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.2605	.27	.6477E+03	.9148E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.2605	.27	.6477E+03	.9148E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.2605	.27	.6477E+03	.9148E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.1753	.12	.2931E+03	.4677E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.1753	.12	.2931E+03	.4677E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.1753	.12	.2931E+03	.4677E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.1753	.12	.2931E+03	.4677E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.1753	.12	.2931E+03	.4677E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.1753	.12	.2931E+03	.4677E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.1753	.12	.2931E+03	.4677E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.1753	.12	.2931E+03	.4677E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.0882	.00	.9997E+01	.1731E+00
42	42	0	.1732E-01	.224573	-.336097	.550830	.0882	.00	.9997E+01	.1731E+00
43	43	0	.1732E-01	.336097	-.224573	.550830	.0882	.00	.9997E+01	.1731E+00
44	44	0	.1732E-01	.396454	-.078860	.550830	.0882	.00	.9997E+01	.1731E+00
45	45	0	.1732E-01	.396454	.078860	.550830	.0882	.00	.9997E+01	.1731E+00
46	46	0	.1732E-01	.336097	.224573	.550830	.0882	.00	.9997E+01	.1731E+00
47	47	0	.1732E-01	.224573	.336097	.550830	.0882	.00	.9997E+01	.1731E+00
48	48	0	.1732E-01	.078860	.396454	.550830	.0882	.00	.9997E+01	.1731E+00
49	49	1	.9009E-02	.084267	-.423638	.625153	.0223	0.00	0.	0.
50	50	1	.9009E-02	.239971	-.359143	.625153	.0223	0.00	0.	0.
51	51	1	.9009E-02	.359143	-.239971	.625153	.0223	0.00	0.	0.
52	52	1	.9009E-02	.423638	-.084267	.625153	.0223	0.00	0.	0.
53	53	1	.9009E-02	.423638	.084267	.625153	.0223	0.00	0.	0.
54	54	1	.9009E-02	.359143	.239971	.625153	.0223	0.00	0.	0.
55	55	1	.9009E-02	.239971	.359143	.625153	.0223	0.00	0.	0.
56	56	1	.9009E-02	.084267	.423638	.625153	.0223	0.00	0.	0.

FX = 0. FD = .4515229E+03 FN = -.9426822E-07 SMX = -.7883373E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2370421 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 14 DEPTH = .7000010 TIME = .0118703 DIMENSIONLESS TIME .5935161 WETTING FACTORS = 1.1063200 1.0895000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000RIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.5405	.86	.2081E+04	.6796E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.5405	.86	.2081E+04	.6796E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.5405	.86	.2081E+04	.6796E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.5405	.86	.2081E+04	.6796E+01

5	5	0	.3265E-02	.072081	.014338	.066637	.5405	.86	.2081E+04	.6796E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.5405	.86	.2081E+04	.6796E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.5405	.86	.2081E+04	.6796E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.5405	.86	.2081E+04	.6796E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.4693	.64	.1543E+04	.1275E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.4693	.64	.1543E+04	.1275E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.4693	.64	.1543E+04	.1275E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.4693	.64	.1543E+04	.1275E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.4693	.64	.1543E+04	.1275E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.4693	.64	.1543E+04	.1275E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.4693	.64	.1543E+04	.1275E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.4693	.64	.1543E+04	.1275E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.3889	.43	.1038E+04	.1211E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.3889	.43	.1038E+04	.1211E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.3889	.43	.1038E+04	.1211E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.3889	.43	.1038E+04	.1211E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.3889	.43	.1038E+04	.1211E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.3889	.43	.1038E+04	.1211E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.3889	.43	.1038E+04	.1211E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.3889	.43	.1038E+04	.1211E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.3057	.25	.6041E+03	.8533E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.3057	.25	.6041E+03	.8533E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.3057	.25	.6041E+03	.8533E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.3057	.25	.6041E+03	.8533E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.3057	.25	.6041E+03	.8533E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.3057	.25	.6041E+03	.8533E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.3057	.25	.6041E+03	.8533E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.3057	.25	.6041E+03	.8533E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.2205	.10	.2515E+03	.4012E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.2205	.10	.2515E+03	.4012E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.2205	.10	.2515E+03	.4012E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.2205	.10	.2515E+03	.4012E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.2205	.10	.2515E+03	.4012E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.2205	.10	.2515E+03	.4012E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.2205	.10	.2515E+03	.4012E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.2205	.10	.2515E+03	.4012E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.1335	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.1335	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.1335	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.1335	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.1335	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.1335	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.1335	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.1335	0.00	0.	0.
49	49	0	.1835E-01	.085834	-.431519	.650598	.0445	0.00	0.	0.
50	50	0	.1835E-01	.244436	-.365824	.650598	.0445	0.00	0.	0.
51	51	0	.1835E-01	.365824	-.244436	.650598	.0445	0.00	0.	0.
52	52	0	.1835E-01	.431519	-.085834	.650598	.0445	0.00	0.	0.
53	53	0	.1835E-01	.431519	.085834	.650598	.0445	0.00	0.	0.
54	54	0	.1835E-01	.365824	.244436	.650598	.0445	0.00	0.	0.
55	55	0	.1835E-01	.244436	.365824	.650598	.0445	0.00	0.	0.
56	56	0	.1835E-01	.085834	.431519	.650598	.0445	0.00	0.	0.

FX = 0. FD = .4307726E+03 FN = -.4762023E-07 SMX = -.4480727E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2261867 CN = -.0000060 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 15 DEPTH = .7500010 TIME = .0127832 DIMENSIONLESS TIME .6394088 WETTING FACTORS = 1.0895000 1.0811000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.00ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.5864	.84	.2039E+04	.6656E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.5864	.84	.2039E+04	.6656E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.5864	.84	.2039E+04	.6656E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.5864	.84	.2039E+04	.6656E+01

5	5	0	.3265E-02	.072081	.014338	.066637	.5864	.84	.2039E+04	.6656E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.5864	.84	.2039E+04	.6656E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.5864	.84	.2039E+04	.6656E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.5864	.84	.2039E+04	.6656E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.5152	.62	.1500E+04	.1240E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.5152	.62	.1500E+04	.1240E+02
11	11	0	.8265E-02	.132378	-.088452	.154806	.5152	.62	.1500E+04	.1240E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.5152	.62	.1500E+04	.1240E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.5152	.62	.1500E+04	.1240E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.5152	.62	.1500E+04	.1240E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.5152	.62	.1500E+04	.1240E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.5152	.62	.1500E+04	.1240E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.4348	.41	.9924E+03	.1158E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.4348	.41	.9924E+03	.1158E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.4348	.41	.9924E+03	.1158E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.4348	.41	.9924E+03	.1158E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.4348	.41	.9924E+03	.1158E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.4348	.41	.9924E+03	.1158E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.4348	.41	.9924E+03	.1158E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.4348	.41	.9924E+03	.1158E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.3516	.23	.5538E+03	.7822E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.3516	.23	.5538E+03	.7822E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.3516	.23	.5538E+03	.7822E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.3516	.23	.5538E+03	.7822E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.3516	.23	.5538E+03	.7822E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.3516	.23	.5538E+03	.7822E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.3516	.23	.5538E+03	.7822E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.3516	.23	.5538E+03	.7822E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.2664	.08	.1922E+03	.3067E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.2664	.08	.1922E+03	.3067E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.2664	.08	.1922E+03	.3067E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.2664	.08	.1922E+03	.3067E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.2664	.08	.1922E+03	.3067E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.2664	.08	.1922E+03	.3067E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.2664	.08	.1922E+03	.3067E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.2664	.08	.1922E+03	.3067E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.1793	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.1793	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.1793	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.1793	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.1793	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.1793	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.1793	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.1793	0.00	0.	0.
49	49	0	.1835E-01	.085834	-.431519	.650598	.0904	0.00	0.	0.
50	50	0	.1835E-01	.244436	-.365824	.650598	.0904	0.00	0.	0.
51	51	0	.1835E-01	.365824	-.244436	.650598	.0904	0.00	0.	0.
52	52	0	.1835E-01	.431519	-.085834	.650598	.0904	0.00	0.	0.
53	53	0	.1835E-01	.431519	.085834	.650598	.0904	0.00	0.	0.
54	54	0	.1835E-01	.365824	.244436	.650598	.0904	0.00	0.	0.
55	55	0	.1835E-01	.244436	.365824	.650598	.0904	0.00	0.	0.
56	56	0	.1835E-01	.085834	.431519	.650598	.0904	0.00	0.	0.
57	57	1	.9430E-02	.090031	-.452617	.725107	.0228	0.00	0.	0.
58	58	1	.9430E-02	.256387	-.383710	.725107	.0228	0.00	0.	0.
59	59	1	.9430E-02	.383710	-.256387	.725107	.0228	0.00	0.	0.
60	60	1	.9430E-02	.452617	-.090031	.725107	.0228	0.00	0.	0.
61	61	1	.9430E-02	.452617	.090031	.725107	.0228	0.00	0.	0.
62	62	1	.9430E-02	.383710	.256387	.725107	.0228	0.00	0.	0.
63	63	1	.9430E-02	.256387	.383710	.725107	.0228	0.00	0.	0.
64	64	1	.9430E-02	.090031	.452617	.725107	.0228	0.00	0.	0.

FX = 0. FD = .4077368E+03 FN = -.5213650E-07 SMX = -.4620892E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2140313 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 16 DEPTH = .8800010 TIME = .0137132 DIMENSIONLESS TIME .6856579 WETTING FACTORS = 1.0811000 1.0671000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.6326	.83	.2004E+04	.6543E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.6326	.83	.2004E+04	.6543E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.6326	.83	.2004E+04	.6543E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.6326	.83	.2004E+04	.6543E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.6326	.83	.2004E+04	.6543E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.6326	.83	.2004E+04	.6543E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.6326	.83	.2004E+04	.6543E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.6326	.83	.2004E+04	.6543E+01
9	9	0	.8265E-02	.031060	-.156150	.154806	.5615	.60	.1466E+04	.1212E+02
10	10	0	.8265E-02	.088452	-.132378	.154806	.5615	.60	.1466E+04	.1212E+02
11	11	0	.8265E-02	.132370	-.088452	.154806	.5615	.60	.1466E+04	.1212E+02
12	12	0	.8265E-02	.156150	-.031060	.154806	.5615	.60	.1466E+04	.1212E+02
13	13	0	.8265E-02	.156150	.031060	.154806	.5615	.60	.1466E+04	.1212E+02
14	14	0	.8265E-02	.132378	.088452	.154806	.5615	.60	.1466E+04	.1212E+02
15	15	0	.8265E-02	.088452	.132378	.154806	.5615	.60	.1466E+04	.1212E+02
16	16	0	.8265E-02	.031060	.156150	.154806	.5615	.60	.1466E+04	.1212E+02
17	17	0	.1167E-01	.046486	-.233698	.252593	.4810	.39	.9571E+03	.1117E+02
18	18	0	.1167E-01	.132380	-.198120	.252593	.4810	.39	.9571E+03	.1117E+02
19	19	0	.1167E-01	.198120	-.132380	.252593	.4810	.39	.9571E+03	.1117E+02
20	20	0	.1167E-01	.233698	-.046486	.252593	.4810	.39	.9571E+03	.1117E+02
21	21	0	.1167E-01	.233698	.046486	.252593	.4810	.39	.9571E+03	.1117E+02
22	22	0	.1167E-01	.198120	.132380	.252593	.4810	.39	.9571E+03	.1117E+02
23	23	0	.1167E-01	.132380	.198120	.252593	.4810	.39	.9571E+03	.1117E+02
24	24	0	.1167E-01	.046486	.233698	.252593	.4810	.39	.9571E+03	.1117E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.3978	.21	.5172E+03	.7305E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.3978	.21	.5172E+03	.7305E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.3978	.21	.5172E+03	.7305E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.3978	.21	.5172E+03	.7305E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.3978	.21	.5172E+03	.7305E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.3978	.21	.5172E+03	.7305E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.3978	.21	.5172E+03	.7305E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.3978	.21	.5172E+03	.7305E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.3126	.06	.1538E+03	.2453E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.3126	.06	.1538E+03	.2453E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.3126	.06	.1538E+03	.2453E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.3126	.06	.1538E+03	.2453E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.3126	.06	.1538E+03	.2453E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.3126	.06	.1538E+03	.2453E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.3126	.06	.1538E+03	.2453E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.3126	.06	.1538E+03	.2453E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.2256	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.2256	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.2256	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.2256	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.2256	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.2256	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.2256	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.2256	0.00	0.	0.
49	49	0	.1835E-01	.085834	-.431519	.650598	.1366	0.00	0.	0.
50	50	0	.1835E-01	.244436	-.365824	.650598	.1366	0.00	0.	0.
51	51	0	.1835E-01	.365824	-.244436	.650598	.1366	0.00	0.	0.
52	52	0	.1835E-01	.431519	-.085834	.650598	.1366	0.00	0.	0.
53	53	0	.1835E-01	.431519	.085834	.650598	.1366	0.00	0.	0.
54	54	0	.1835E-01	.365824	.244436	.650598	.1366	0.00	0.	0.
55	55	0	.1835E-01	.244436	.365824	.650598	.1366	0.00	0.	0.
56	56	0	.1835E-01	.085834	.431519	.650598	.1366	0.00	0.	0.
57	57	0	.1910E-01	.091194	-.458461	.750420	.0457	0.00	0.	0.
58	58	0	.1910E-01	.259697	-.388665	.750420	.0457	0.00	0.	0.
59	59	0	.1910E-01	.388665	-.259697	.750420	.0457	0.00	0.	0.
60	60	0	.1910E-01	.458461	-.091194	.750420	.0457	0.00	0.	0.
61	61	0	.1910E-01	.458461	.091194	.750420	.0457	0.00	0.	0.
62	62	0	.1910E-01	.388665	.259697	.750420	.0457	0.00	0.	0.

63	63	0	.1910E-01	.259697	.388665	.750420	.0457	0.00	0.	0.
64	64	0	.1910E-01	.091194	.458461	.750420	.0457	0.00	0.	0.

FX = 0. FD = .3507734E+03 FN = -.5292426E-07 SMX = -.4581138E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .2851874 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

STEP 17 DEPTH = .8500010 TIME = .0146503 DIMENSIONLESS TIME .7325139 WETTING FACTORS = 1.0671000 1.0615000
AVERAGE VELOCITY 0.000 0.000 -50.000 WX 0.000 ORIENTATION 90.000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.3265E-02	.014338	-.072081	.066637	.6795	.81	.1967E+04	.6421E+01
2	2	0	.3265E-02	.040831	-.061108	.066637	.6795	.81	.1967E+04	.6421E+01
3	3	0	.3265E-02	.061108	-.040831	.066637	.6795	.81	.1967E+04	.6421E+01
4	4	0	.3265E-02	.072081	-.014338	.066637	.6795	.81	.1967E+04	.6421E+01
5	5	0	.3265E-02	.072081	.014338	.066637	.6795	.81	.1967E+04	.6421E+01
6	6	0	.3265E-02	.061108	.040831	.066637	.6795	.81	.1967E+04	.6421E+01
7	7	0	.3265E-02	.040831	.061108	.066637	.6795	.81	.1967E+04	.6421E+01
8	8	0	.3265E-02	.014338	.072081	.066637	.6795	.81	.1967E+04	.6421E+01
9	9	0	.8265E-02	.031060	-.156150	.154606	.6083	.59	.1428E+04	.1180E+02
10	10	0	.8265E-02	.088452	-.132378	.154606	.6083	.59	.1428E+04	.1180E+02
11	11	0	.8265E-02	.132378	-.088452	.154606	.6083	.59	.1428E+04	.1180E+02
12	12	0	.8265E-02	.156150	-.031060	.154606	.6083	.59	.1428E+04	.1180E+02
13	13	0	.8265E-02	.156150	.031060	.154606	.6083	.59	.1428E+04	.1180E+02
14	14	0	.8265E-02	.132378	.088452	.154606	.6083	.59	.1428E+04	.1180E+02
15	15	0	.8265E-02	.088452	.132378	.154606	.6083	.59	.1428E+04	.1180E+02
16	16	0	.8265E-02	.031060	.156150	.154606	.6083	.59	.1428E+04	.1180E+02
17	17	0	.1147E-01	.046486	-.233698	.252593	.5279	.38	.9164E+03	.1070E+02
18	18	0	.1147E-01	.132380	-.198120	.252593	.5279	.38	.9164E+03	.1070E+02
19	19	0	.1147E-01	.198120	-.132380	.252593	.5279	.38	.9164E+03	.1070E+02
20	20	0	.1147E-01	.233698	-.046486	.252593	.5279	.38	.9164E+03	.1070E+02
21	21	0	.1147E-01	.233698	.046486	.252593	.5279	.38	.9164E+03	.1070E+02
22	22	0	.1147E-01	.198120	.132380	.252593	.5279	.38	.9164E+03	.1070E+02
23	23	0	.1147E-01	.132380	.198120	.252593	.5279	.38	.9164E+03	.1070E+02
24	24	0	.1147E-01	.046486	.233698	.252593	.5279	.38	.9164E+03	.1070E+02
25	25	0	.1413E-01	.059408	-.298665	.351667	.4447	.19	.4723E+03	.6671E+01
26	26	0	.1413E-01	.169180	-.253196	.351667	.4447	.19	.4723E+03	.6671E+01
27	27	0	.1413E-01	.253196	-.169180	.351667	.4447	.19	.4723E+03	.6671E+01
28	28	0	.1413E-01	.298665	-.059408	.351667	.4447	.19	.4723E+03	.6671E+01
29	29	0	.1413E-01	.298665	.059408	.351667	.4447	.19	.4723E+03	.6671E+01
30	30	0	.1413E-01	.253196	.169180	.351667	.4447	.19	.4723E+03	.6671E+01
31	31	0	.1413E-01	.169180	.253196	.351667	.4447	.19	.4723E+03	.6671E+01
32	32	0	.1413E-01	.059408	.298665	.351667	.4447	.19	.4723E+03	.6671E+01
33	33	0	.1595E-01	.070115	-.352493	.451159	.3595	.04	.1026E+03	.1638E+01
34	34	0	.1595E-01	.199671	-.298829	.451159	.3595	.04	.1026E+03	.1638E+01
35	35	0	.1595E-01	.298829	-.199671	.451159	.3595	.04	.1026E+03	.1638E+01
36	36	0	.1595E-01	.352493	-.070115	.451159	.3595	.04	.1026E+03	.1638E+01
37	37	0	.1595E-01	.352493	.070115	.451159	.3595	.04	.1026E+03	.1638E+01
38	38	0	.1595E-01	.298829	.199671	.451159	.3595	.04	.1026E+03	.1638E+01
39	39	0	.1595E-01	.199671	.298829	.451159	.3595	.04	.1026E+03	.1638E+01
40	40	0	.1595E-01	.070115	.352493	.451159	.3595	.04	.1026E+03	.1638E+01
41	41	0	.1732E-01	.078860	-.396454	.550830	.2725	0.00	0.	0.
42	42	0	.1732E-01	.224573	-.336097	.550830	.2725	0.00	0.	0.
43	43	0	.1732E-01	.336097	-.224573	.550830	.2725	0.00	0.	0.
44	44	0	.1732E-01	.396454	-.078860	.550830	.2725	0.00	0.	0.
45	45	0	.1732E-01	.396454	.078860	.550830	.2725	0.00	0.	0.
46	46	0	.1732E-01	.336097	.224573	.550830	.2725	0.00	0.	0.
47	47	0	.1732E-01	.224573	.336097	.550830	.2725	0.00	0.	0.
48	48	0	.1732E-01	.078860	.396454	.550830	.2725	0.00	0.	0.
49	49	0	.1835E-01	.085834	-.431519	.650598	.1835	0.00	0.	0.
50	50	0	.1835E-01	.244436	-.365824	.650598	.1835	0.00	0.	0.
51	51	0	.1835E-01	.365824	-.244436	.650598	.1835	0.00	0.	0.
52	52	0	.1835E-01	.431519	-.085834	.650598	.1835	0.00	0.	0.
53	53	0	.1835E-01	.431519	.085834	.650598	.1835	0.00	0.	0.
54	54	0	.1835E-01	.365824	.244436	.650598	.1835	0.00	0.	0.

55	55	0	.1835E-01	.244436	.365324	.550598	.1835	0.00	0.	0.
56	56	0	.1835E-01	.085834	.431519	.550596	.1835	0.00	0.	0.
57	57	0	.1910E-01	.091194	-.458461	.750420	.0925	0.00	0.	0.
58	58	0	.1910E-01	.259697	-.388665	.750420	.0925	0.00	0.	0.
59	59	0	.1910E-01	.388665	-.259697	.750420	.0925	0.00	0.	0.
60	60	0	.1910E-01	.458461	-.091194	.750420	.0925	0.00	0.	0.
61	61	0	.1910E-01	.458461	.091194	.750420	.0925	0.00	0.	0.
62	62	0	.1910E-01	.388665	.259697	.750420	.0925	0.00	0.	0.
63	63	0	.1910E-01	.259697	.388665	.750420	.0925	0.00	0.	0.
64	64	0	.1910E-01	.091194	.458461	.750420	.0925	0.00	0.	0.
65	65	1	.9734E-02	.094258	-.473869	.825070	.0234	0.00	0.	0.
66	66	1	.9734E-02	.268425	-.401727	.825070	.0234	0.00	0.	0.
67	67	1	.9734E-02	.401727	-.268425	.825070	.0234	0.00	0.	0.
68	68	1	.9734E-02	.473869	-.094258	.825070	.0234	0.00	0.	0.
69	69	1	.9734E-02	.473869	.094258	.825070	.0234	0.00	0.	0.
70	70	1	.9734E-02	.401727	.268425	.825070	.0234	0.00	0.	0.
71	71	1	.9734E-02	.268425	.401727	.825070	.0234	0.00	0.	0.
72	72	1	.9734E-02	.094258	.473869	.825070	.0234	0.00	0.	0.

FX = 0. FD = .3703989E+03 FN = -.5381493E-07 SMX = -.4525484E-07 SMY = 0. SMZ = 0.
CX = 0.0000000 CD = .1944862 CN = -.0000000 MX = -.0000000 MY = 0.0000000 MZ = 0.0000000

EXAMPLE 4

```
*******PROGRAM OPTIONS*******
CONSTANT BODY ORIENTATION
DON'T PRINT
SYMMETRIC  CONFIGURATION

*******PROBLEM PARAMETERS*******
        DIAMETER  .2500 FT
        ENTRY VELOCITY     100.000(FT/SEC)
        BODY ORIENTATION ANGLE  60.00 DEGREES
  INITIAL DEPTH     .12500 FT    TERMINATION STEP  1
     INITIAL PRESSURE CORRECTION FACTOR =  1.0000
CENTROIDE COORDINATES      0.00000     0.00000     0.00000
       INCREMENT IN DEPTH    .0125000
        ANGLE OF ATTACK     0.00
          YAW ANGLE     0.00

        WETTING FACTORS
           1.45000

*******GRID OPTIONS*******
        STANDARD
        LIST
```

GRID SIZE

R	Z	NUMBER
.025000	0.000000	1
.075000	0.000000	4
.125000	0.000000	7

NODE	X	Y	Z	XP	YP	ZP
1	0.0000	-.0250	0.0000	0.0000	-.1299	-.0500
2	.0217	-.0125	0.0000	.0217	-.1191	-.0563
3	.0217	.0125	0.0000	.0217	-.0974	-.0688
4	-.0000	.0250	0.0000	-.0000	-.0866	-.0750
5	0.0000	-.0250	0.0000	0.0000	-.1299	-.0500
6	.0177	-.0177	0.0000	.0177	-.1236	-.0537
7	.0250	.0000	0.0000	.0250	-.1083	-.0625
8	.0177	.0177	0.0000	.0177	-.0929	-.0713
9	-.0000	.0250	0.0000	-.0000	-.0866	-.0750
10	0.0000	-.0750	0.0000	0.0000	-.1732	-.0250
11	.0530	-.0530	0.0000	.0530	-.1542	-.0360
12	.0750	.0000	0.0000	.0750	-.1083	-.0625
13	.0530	.0530	0.0000	.0530	-.0623	-.0890
14	-.0000	.0750	0.0000	-.0000	-.0433	-.1000
15	0.0000	-.0750	0.0000	0.0000	-.1732	-.0250
16	.0325	-.0676	0.0000	.0325	-.1668	-.0287
17	.0586	-.0468	0.0000	.0586	-.1488	-.0391
18	.0731	-.0167	0.0000	.0731	-.1227	-.0542
19	.0731	.0167	0.0000	.0731	-.0938	-.0708
20	.0586	.0468	0.0000	.0586	-.0678	-.0859
21	.0325	.0676	0.0000	.0325	-.0497	-.0963
22	-.0000	.0750	0.0000	-.0000	-.0433	-.1000
23	0.0000	-.1250	0.0000	0.0000	-.2165	-.0000
24	.0542	-.1126	0.0000	.0542	-.2058	-.0062
25	.0977	-.0779	0.0000	.0977	-.1757	-.0235
26	.1219	-.0278	0.0000	.1219	-.1323	-.0486
27	.1219	.0278	0.0000	.1219	-.0842	-.0764
28	.0977	.0779	0.0000	.0977	-.0408	-.1015
29	.0542	.1126	0.0000	.0542	-.0107	-.1188
30	-.0000	.1250	0.0000	-.0000	-.0000	-.1250
31	0.0000	-5.0000	3.2300	0.0000	-2.8234	5.2340
32	1.2200	-3.5500	3.2300	1.2200	-1.5476	6.5000

33	1.8500	-2.1000	3.2300	1.8500	-.3119	3.7848
34	1.7500	-.4100	3.2300	1.7500	1.1517	2.9398
35	.9900	.4500	3.2300	.9900	1.8965	2.5098
36	.8000	.6700	3.2300	.8000	2.0870	2.3998
37	.6400	.8000	3.2300	.6400	2.1996	2.3340
38	0.0000	.9000	3.2300	0.0000	2.2862	2.2848

ELEMENT	1	2	3	4	XC	YC	ZC	RC	TC	AREA
1	1	2	3	4	.00962	.00000	0.00000	.00962	90.000	.8119E-03
2	10	11	6	5	.01915	-.04623	0.00000	.05004	157.500	.1768E-02
3	11	12	7	6	.04623	-.01915	0.00000	.05004	112.500	.1768E-02
4	12	13	8	7	.04623	.01915	0.00000	.05004	67.500	.1768E-02
5	13	14	9	8	.01915	.04623	0.00000	.05004	22.500	.1768E-02
6	23	24	16	15	.02215	-.09703	0.00000	.09952	167.143	.2169E-02
7	24	25	17	16	.06205	-.07781	0.00000	.09952	141.429	.2169E-02
8	25	26	18	17	.08967	-.04318	0.00000	.09952	115.714	.2169E-02
9	26	27	19	18	.09952	.00000	0.00000	.09952	90.000	.2169E-02
10	27	28	20	19	.08967	.04318	0.00000	.09952	64.286	.2169E-02
11	28	29	21	20	.06205	.07781	0.00000	.09952	38.571	.2169E-02
12	29	30	22	21	.02215	.09703	0.00000	.09952	12.857	.2169E-02
	NO LOAD ELEMENTS									
13	31	32	24	23	.40999	-2.04611	2.11427	2.07549	171.003	.4405E+01
14	32	33	25	24	1.03232	-1.80321	2.11091	2.14760	151.270	.3318E+01
15	33	34	26	25	1.22898	-.84199	2.11494	1.48315	124.590	.3165E+01
16	34	35	27	26	.93961	.01471	2.09996	.93972	89.103	.2029E+01
17	35	36	28	27	.59281	.36481	1.97982	.69607	58.392	.5818E+00
18	36	37	29	28	.45967	.47640	1.92457	.66201	43.976	.4390E+00
19	37	38	30	29	.21477	.58753	2.06799	.62555	20.079	.1168E+01

STEP 1 COMPLETE.CP TIME FOR STEP IS 4.13100

STEP 2 COMPLETE.CP TIME FOR STEP IS 4.14700

STEP 3 COMPLETE.CP TIME FOR STEP IS 4.02600

STEP 2 DEPTH = .1500000 TIME = .0011945 DIMENSIONLESS TIME .4778071 WETTING FACTOR = 1.4500000

NO.	REF.NO.	MOD	AREA	X	Y	Z	T*	CP	P	FORCE
1	1	0	.8119E-03	.009623	.000000	.000000	.2787	1.72	.1670E+05	.1356E+02
2	2	0	.1768E-02	.019151	-.046234	-.000000	.2051	1.83	.1776E+05	.3139E+02
3	3	0	.1768E-02	.046234	-.019151	-.000000	.2482	1.73	.1680E+05	.2970E+02
4	4	0	.1768E-02	.046234	.019151	.000000	.3092	1.63	.1582E+05	.2796E+02
5	5	0	.1768E-02	.019151	.046234	.000000	.3524	1.58	.1531E+05	.2706E+02
6	6	0	.2169E-02	.022146	-.097029	-.000000	.1242	2.06	.2002E+05	.4342E+02
7	7	0	.2169E-02	.062052	-.077811	-.000000	.1548	1.89	.1834E+05	.3979E+02
8	8	0	.2169E-02	.089669	-.043182	-.000000	.2099	1.70	.1651E+05	.3583E+02
9	9	0	.2169E-02	.099524	.000000	.000000	.2787	1.53	.1483E+05	.3217E+02
10	10	0	.2169E-02	.089668	.043182	.000000	.3475	1.43	.1387E+05	.3008E+02
11	11	0	.2169E-02	.062052	.077811	.000000	.4026	1.37	.1330E+05	.2886E+02
12	12	0	.2169E-02	.022146	.097029	.000000	.4333	1.35	.1309E+05	.2839E+02
			NO LOAD ELEMENTS							
13	13	1	.1817E-02	.030120	-.130831	.009455	.0443	.01	0.	0.
14	14	1	.2642E-02	.085860	-.107017	.016468	.0628	.01	0.	0.
15	15	1	.4774E-02	.128177	-.060338	.032246	.0937	.05	0.	0.
16	16	1	.7606E-02	.142082	.003814	.054979	.1331	-.01	0.	0.
17	17	1	.9146E-02	.127434	.065998	.074771	.1776	-.02	0.	0.
18	18	1	.1093E-01	.093331	.113687	.090321	.2106	.01	0.	0.
19	19	1	.1475E-01	.036173	.142951	.105474	.2154	.02	0.	0.

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